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Reports from the AMERICAN CHEMICAL SOCIETY meeting in Chicago

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Editorial:
Fundamental Stuff of the Universe
Inside Front Cover

OCTOBER 1961

50¢

Thirty-fifth Year

A SCIENCE SERVICE PUBLICATION

Fundamental Stuff of The Universe

➤ THE STORY of the kinds of atoms has been long in composition, with many minds and hands putting it together. The ancients knew and recognized some of the elements, such as gold, silver, copper, etc., found in their native state. Others, even some of the most common, long remained hidden, in disguise of some other element or in the crudeness of early chemistry.

There are just so many kinds of matter out of which the universe is made. Man has been able to discover 103 chemical elements — some of which he has created for a very momentary existence, and others like hydrogen and helium which seem to hold a heavy and stable majority in the universe. Some of these elements have been found or created in only the few years after the great atomic energy push. There are hundreds of varieties of these elements — isotopes they are called — many artificially radioactive and not found in nature.

The present frontier of the chemical elements lies in the mystery of what composes them. Just what more fundamental particles make them up and what laws and forces keep their nuclei together is the prime question of physical science. Scientists are trying to pry loose the answer with cosmic rays and gigantic accelerators.

* * * *

This editorial is taken from the preface to the book, "The Chemical Elements" by Helen Miles Davis. Send Fifty cents to CHEMISTRY, 1719 N Street, N.W., Washington 6, D. C. for a copy of the 1961 edition.

CHEMISTRY

Vol. 35, No. 2 — Formerly Chemistry Leaflet — October, 1961

Including The Science Leaflet

Published monthly, September through April, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 326 W. Beaver Ave., State College, Pa. Second class postage paid at State College, Pa., and at additional mailing offices. Address subscription and editorial communications to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

$4 a Year; Two-Year Subscriptions $7; Your Own and a Gift Subscription $7 a Year. 50¢ a Copy. Ten or more subscriptions to the same address: $2.90 a Year each. No charge for Foreign or Canadian Postage.

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Highlights from the 140th National Meeting of the American Chemical Society at Chicago in September

Sawdust Steaks

▸ SAWDUST can taste like steak when chemists put the flavor in it, the American Chemical Society meeting was told.

The flavor in meat is caused by simple chemical compounds that can be reproduced and placed in foods before cooking to produce a mouth-watering meat flavor at will, Dr. Wendell A. Landmann of the American Meat Institute Foundation, Chicago, reported.

Meat has been separated into water-soluble materials, fat, and water-insoluble materials, Dr. Landmann explained. After heating these fractions, the scientist found the meat flavor and aroma only in the water-soluble material. Further separation of this material showed that the fundamental meat flavor could be produced from two compounds, inosinic acid and a protein that contained sugar. These compounds in themselves have no odor, but when these are mixed and heated with fat or water, the odor and taste of broiled or boiled meat is obtainable, he said.

"The housewife will be able to tailor meat flavor to suit individual tastes of her family and she can be sure of uniform flavor quality when she purchases a steak," Dr. Landmann said. Applications to space-feeding and to the synthetic foods for future populations are also being explored.

Organic Research

Synthetic Rubber Breakthrough

▸ A BREAKTHROUGH in rubber science now permits the industry to make any kind of synthetic rubber that is needed, George R. Vila, president of United States Rubber Co., said at the 140th national meeting of the American Chemical Society.

Mr. Vila and three of his company's scientists described three new types of synthetics superior in many ways to materials now in use and likely to bring improvements to tires, conveyor belts, golf balls and other products.

We have entered a revolution in rubber and rubber-like materials, said Mr. Vila, who served as chairman of this joint symposium of the society's rubber and petroleum sections on synthetic elastomers from petroleum hydrocarbons.

ACS Meeting

"We have shaken ourselves free from the molecular designs of mother nature and the previously uncontrollable course of synthetic molecular structure. We can now build molecules exactly to the specifications we wish."

Ethylene-propylene rubber is a highly versatile class of rubbers, Dr. Robert J. Kelly told the symposium. It can be made extremely resistant to ozone cracking and weathering and has a generally well balanced set of physical properties. EPR, as it is called, has the bounce of natural rubber, the wear of general-purpose styrene-butadiene rubbers and the ozone resistance of butyl.

U. S. Rubber scientists developed successful synthetic balata as an outgrowth of studies in stereo-regular polymerization that began in 1954. The substance is a moderately hard, tough, crystalline thermoplastic material known by the chemical name of "trans 1,4 polyisoprene."

Synthetic balata's development is expected to free the rubber industry from dependence on natural balata latex, which must be bled from the bark of the balata tree deep in the jungles of South America. The natural product has become more difficult and expensive to obtain because each season workers must go farther into the jungle in search of trees.

Vinyl pyridine synthetic rubber is extremely resistant to abrasion and gives higher performance with the addition of certain inorganic chemicals, said Dr. William F. Bruksch Jr. It will perform well in tire treads and conveyor belts, where abrasion resistance is an advantage in longer wear.

Mr. Vila foresaw further research to develop polymers with the ultimate in resistance to heat, light, oxygen, ozone and high-energy radiation. Survival on other planets will require us to meet the demands of extreme temperature ranges, entirely new atmospheres and bombardment by cosmic radiation.

Dr. Kelly was assisted in the preparation of his technical paper by Dr. Harold K. Garner, Dr. Henry E. Haxo and William R. Bingham.

Co-authors with Dr. Lasky were Dr. Roswell H. Ewart and Dr. Garner.

Dr. Bruksch is a research scientist with the company's Naugatuck Chemical division working at the Research Center.

Witch Doctors' Brew

➤ A WITCH doctors' secret poison, once used as an instrument of terror, has now been made in the laboratory, it was reported at the 140th national meeting of the American Chemical Society.

Synthesis of the poisonous substance, which occurs in a West African shrub called "ratsbane," was announced by Dr. F. L. M. Pattison and R. E. A. Dear of the University of Western Ontario, London, Ontario.

Extremely toxic to all warm-blooded animals, ratsbane was extensively used in Africa at one time as a rat-killer, an arrow poison, and a fatal contaminant in enemy water supplies.

"It was employed to even greater effect by the local witch doctors for terrorizing the native population," Dr. Pattison said. "European doctors knew the symptoms only too well, but in the early days they did not know what material the witch doctors used, so no cures were possible.

"Then in 1904 a young Mendi laborer calley Johnny ate some fish which had been poisoned with ratsbane for killing rats. He soon developed the well known symptoms. So the witch doctors' secret was out."

Paralysis of the lower limbs is one of the characteristic symptoms of ratsbane poisoning, according to Dr. Pattison, leading to a second common name for the shrub — "brokeback."

The toxic agent from ratsbane was not identified chemically until 1960, when it was concluded by Sir Rudolph Peters, an English chemist, that the substance is a fluoro-oleic acid, the second organic chemical containing fluorine ever to be found in nature. It is closely related chemically to oleic acid, a constituent of ordinary fats, Dr. Pattison explained.

The other naturally occurring organic fluorine compound is fluoroacetic acid, also a highly toxic constituent of African plant species.

The synthesis was undertaken, Dr. Pattison reported, in order to confirm the structure of the ratsbane poison. It is not expected to be of any immediate practical use.

Starting point for the synthesis was a simpler fluorine-containing compound, 8-fluoro-octyl bromide, the chemist said. Intermediates included several materials related to acetylene. The final synthetic product proved to be identical with the toxic substance from ratsbane, thus demonstrating that the proposed structure was correct.

Dr. Pattison's paper was given before the Fluorine Subdivision of the Division of Industrial and Engineering Chemistry, one of 23 units of the American Chemical Society devoted to the various branches of chemistry and chemical technology.

Straight-Jacketed Molecules

▸ A CHEMIST has put straight jackets on violent molecules so they can be handled in research on rocket fuels, he told the American Chemical Society.

Dr. Jack Radell of the Frankford Arsenal, Philadelphia, said he and his colleagues have trapped highly explosive "alkyl perchlorate" molecules inside holes in crystals of urea.

In spite of their potential use as oxidizers for rocket fuels, little work has been done with these long, snake-like molecules because of their dangerous instability, he explained. The percholorate "head" of one molecule

may violently attack a neighboring alkyl "tail" — or even its own. The molecules also react explosively with water, he said.

The urea straight jackets keep out water and also prevent the molecules from attacking their neighbors or turning back on themselves, the speaker reported.

Safe handling of the alkyl perchlorates for study and possible use in the explosives and jet fuel fields may now be possible, he said.

The alkyl perchlorates, prepared for the first time by Dr. Radell and his coworkers, are all explosive liquids. The compounds with the shortest alkyl "tails" are the most sensitive to shock, it was indicated.

Treating the alkyl perchlorates with urea in a solution of alcohol resulted in the formation of the urea straight jackets, or "inclusion compounds."

"Formation of urea inclusion compounds converted the liquid alkyl perchlorates to characteristic white crystalline masses of fine needles," Dr. Radell said. "The resulting crystalline complexes had no apparent shock sensitivity in small quantities."

Alkyl perchlorates with tails containing 5 to 8 carbon atoms in a chain were studied. The ease of formation of the urea inclusion compounds was proportional to the chain lengths of the alkyl perchlorates, Dr. Radell stated.

The chemical structure of the urea crystals containing the alkyl perchlorate molecules was verified by studies using X-rays and infrared spectra, it was reported.

Captain J. W. Connolly of the Wright-Patterson Air Force Base and A. J. Raymond of the Wyandotte Chemical Corporation, Wyandotte, Michigan, were co-authors of the paper.

Tapping Oil Shale Deposits

➤ Progress in tapping the trillion-barrel oil potential of a vast Colorado oil shale deposit was reported to the American Chemical Society by a Government chemist.

For the first time kerogen, the oil-forming portion of the shale, has been freed from the tight-clinging mineral portion without drastically changing the kerogen. Until now the mineral has greatly hampered utilization studies, said D. L. Lawlor of the U.S. Bureau of Mines, Laramie, Wyo.

The proportion of the troublesome material, called pyrite, has been reduced from 5 to .02 per cent with a new chemical technique based on a compound called lithium aluminum hydride, he said.

Used in conjunction with established methods of removing impurities, the technique produces a kerogen containing only about 1 per cent total minerals. Investigations of the relatively unaltered sample now make possible research that may lead to

efficient ways of exploiting the huge shale deposit, Mr. Lawlor told the ACS Division of Fuel Chemistry.

"Oil shale is one of the greatest untapped natural resources in the United States," he continued. "The liquid fuel potential of the oil shale deposits located in northwest Colorado in the Green River formation is equivalent to more than one trillion barrels of crude oil.

"This quantity of oil is several times more than all the natural petroleum produced in this country since oil was first discovered in 1859, plus our present proven reserves of petroleum. This natural resource warrants study and development so that it can fill a need in our ever expanding demand for energy from liquid fuels."

Kerogen, the organic portion of oil shale, converts to oil when treated to 850-900 degrees Fahrenheit, the speaker explained. Its intimate mixture with minerals stems from the fact that it was formed from aquatic plants in prehistoric lakes in which rocks, silt, and soluble minerals were carried by rivers and streams.

More than one-half of the oil shale is composed of the mineral portion which has greatly handicapped studies to determine the character of kerogen, according to Mr. Lawlor, who added:

"For the first time, kerogen can be separated from the mineral matter by chemical methods without drastic changes in the structure of kerogen. As a result, more information about the structure of kerogen and the method by which kerogen is converted to useful products should be obtained from the constitution studies."

Such information, he pointed out, is important to the process engineer in designing new and better methods of utilizing this vast natural resource.

Sugar Modified Resin

▸ A STRONGER, cheaper plywood for exterior use may result from a new binding resin made in part from sugar, a New York chemist told the American Chemical Society's 140th national meeting.

The resin is of the phenolic type presently used in preparing exterior plywood but incorporates a large percentage of sugar in the resin mix, it was reported by Dr. Oleg Kononenko, president of Herstein Laboratories, Inc. Exterior plywood, which it widely used in building, obviously needs to be highly resistant to water.

"The use of water-soluble sugar to modify phenolic resins may sound absurd, because even small amounts of unreacted sugar could be leached out by water to weaken the bond," said Dr. Kononenko, who is an organic and pharmaceutical chemist. "However, in the single-step process we have developed, which can be carried out in 20 to 30 minutes, sugar is completely bound chemically.

"The plywoods made with these resins have withstood 13 days or cycles of successive boiling and drying. Commercial exterior plywood samples usually delaminated after seven or eight cycles."

Tensile strength of the plywood — the force needed to pull it apart — could be changed by varying the proportions of the resin mix and the reaction conditions, Dr. Kononenko reported. Tensile strength attained was somewhat higher than that of plywood using ordinary phenolic resins.

"The percentage of wood failure ranged from 80 to 100 percent, which demonstrates that the resin bond is stronger than the wood itself," Dr. Kononenko said.

"Wet tensile strength, determined after boiling the plywood, was substantially the same, demonstrating that the binding strength was not affected by water."

Sugar used in the new resins replaces about half the phenol normally used, and since the price of sugar is substantially less than that of phenol, the product offers distinct economic advantages, the speaker pointed out.

Co-worker with Dr. Kononenko in developing the new resin was Clarence D. Chang, now with the M. W. Kellogg Company, Jersey City, New Jersey. The paper was presented before the American Chemical Society's Division of Organic Coatings and Plastics Chemistry.

Plastic Electrical Conductors

➤ PLASTICS, long considered excellent electrical insulators, have now been made to conduct electricity — even as well as some metals — a Princeton researcher told the American Chemical Society.

"Semiconduction" has been observed in more than 200 types of plastics, or polymers, made at the Princeton University Plastics Laboratory, according to Dr. Herbert A. Pohl, a physical chemist and senior research associate at the Princeton Engineering School. Further research along this line may eventually lead to plastic electronic components, new de-salters for seawater, and fundamental discoveries about photosynthesis, vision, and sunlight-induced skin cancer, he indicated.

Midway between the metals, which carry an electric current very well, and insulators, which do not carry one at all, the new semiconducting plastics have promising properties which point the way to use in certain electronic devices, particularly those operating at high temperatures. But their use in transistors can not yet be foreseen, Dr. Pohl said.

De-salting of seawater and other large scale chemical transformations may be possible with semiconducting polymers by taking advantage of their unique combination of large surface area, semiconducting properties, and the reactive chemical sites along their chain-like molecules, it was suggested. They could operate much as a water softener does in removing salts from water, except that the regenerating step would be replaced by passing an electric current through the material.

A number of important biological processes involving the action of light on plants and animals — such as photosynthesis, vision, development of skin cancer, and certain enzyme re-

actions — all closely involve semiconduction Dr. Pohl said. Study of the process by which the new materials carry an electric current is expected to give fundamental information about these biological processes.

That semiconduction occurs in the new materials by a fundamentally different process than that occurring in the materials in common use as transistors, is shown by their insensitivity to small amounts of impurities, Dr. Pohl reported.

Best known in the form of plastics and synthetic fibers, polymers are compounds with extremely long molecules. Molecules of the new polymers have many units of unsaturation (like those in unsaturated fats) arranged in a special way, which permits them to carry an electric current, it was explained.

Materials synthesized in the present study are not the first semiconducting polymers to be prepared, Dr. Pohl said. However, the present work represents the first extensive study of a whole family of polymers of known structure and good ability to carry a current.

Inorganic Research

Man-Made Halogen Studies

▸ RESEARCH on an element that doesn't exist in nature has confirmed some fundamental ideas about all chemical elements, the American Chemical Society was told.

New facts learned about the man-made, radioactive element astatine have fulfilled scientists' predictions, which were based on the known properties of natural elements, Dr. Evan H. Appleman of the Argonne National Laboratory reported to the Society's Division of Inorganic Chemistry.

First prepared in 1940 in the University of California cyclotron by Nobel Prize-winner Emilio Segre, astatine is so unstable that half of a sample changes to another substance in eight hours. It is so intensely radioactive that only about one billionth of a gram can be handled at one time — much too small an amount to be seen or weighed.

Astatine has remained the only obscure member of a well known family of elements called the halogens, which includes fluorine, chlorine, bromine, and iodine.

Chemists have long wanted more information about astatine, Dr. Appleman said, in order to verify predictions they have made about its properties compared with the other members of the halogen family. Principles established in this way can be extended to other families of elements.

The work carried out at Argonne National Laboratory established that the properties of astatine did correspond to the principles thought to govern the behavior of the halogens, Dr. Appleman reported.

"For instance," he said, "the halo-

gens are classified as non-metals. In fact, they are the most non-metallic of all the elements. However, as we go to the heavier members of the group, we find them beginning to act more and more like metals, and this tendency is most pronounced in astatine, the heaviest halogen.

"We may generalize this result and conclude that, other things being equal, the heavier an element is, the more metallic will its behavior be."

Techniques used in studying the properties of astatine included the incorporation of minute amounts of astatine compounds in crystals of other, closely related halogen compounds, and the distribution of astatine and astatine compounds between layers of water and carbon tetrachloride, the physical-inorganic chemist explained.

"The name halogen means salt-forming," Dr. Appleman said, "and refers to one of the most characteristic properties of these elements. Thus from chlorine, for instance, comes sodium chloride, our common table salt.

"Astatine, the heaviest member of the group, is a strange sort of beast. All of its isotopes are short-lived and highly radioactive. There is no such thing as a stable astatine — hence, this element cannot exist in nature.

"To correlate successfully the trends in properties among the halogens we need a rather thorough knowledge of all members of the group. In the absence of detailed information about astatine, it was difficult to draw reliable conclusions about the halogen family as a whole.

"The chemical elements are of such diverse nature that it is virtually impossible to comprehend the entire spectrum of chemical behavior starting from scratch. It is much more fruitful to look at a group of elements like the halogens.

"This simplifies things considerably, and it is usually possible to understand the differences in behavior that do exist within the family in terms of a few fundamental principles. These principles may then be used to interpret the behavior of the rest of the chemical elments."

Drinking Water Safe From Nuclear Attack

▶ A NUCLEAR WAR will not permanently contaminate our water supply, scientists were told at the American Chemical Society meeting.

A mobile water purification unit has been developed that removes 97% of the plutonium in contaminated water at the rate of 1,500 gallons of water per hour, Maurice Pressman, U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., said.

Although the amount of pollution from a nuclear attack or an accident in an atomic plant is uncertain, the equipment is believed to be capable of reducing contamination to the level set by the National Committee on Radiation Protection as safe during a 30-day emergency period.

Plutonium, used as an explosive component of nuclear weapons and as a fuel for nuclear reactors, is now in large-scale production in the U.S. If the element gets into the body, it tends to concentrate in the bones and can cause tumors or injure the sensitive bone marrow, site of most blood cell formation.

The purification equipment, stored in a van-type object on a two and a half ton truck, can be put into operation within an hour after arrival at the emergency site, it was reported.

Normally, the unit removes 72% of the contamination. By making the water very alkaline, this can be increased to 97.5% in an emergency. Neutralization with acid would then make the water safe and drinkable.

Paints Protect Space Craft

➤ ORBITING with the American satellite Tiros III is a new family of paints designed to protect space craft from excessive heat, the American Chemical Society was told.

By reflecting radiation from the sun and other extra-terrestrial sources, the new coatings may help control the temperature of vehicles carrying spacemen or payloads, reported Merle E. Sibert of the Lockheed Aircraft Corporation's Missile and Space Division, Sunnyvale, Cal. Their formulation of white powders, based on alkali silicates, also avoids compounds that tend to decompose or discolor paints under the drastic conditions in space, he said.

Laboratory tests made previous to the July 12 launching indicated that the paints are capable of "maintaining their optical, chemical, and structural stability for extended periods in the space environment" and far exceed existing requirements, he said at a technical session of the ACS Division of Organic Coatings and Plastics Chemistry.

During the laboratory studies the paints withstood 2,000 hours of sun in a vacuum and were not affected by extreme conditions of temperature and radiation. Their composition, alkali silicates and high purity white ceramic type pigments, contains no discoloring organic materials such as oils, plastics, or silicones, Mr. Sibert pointed out, continuing:

"In current and projected space vehicles, some form of temperature control must be incorporated into the design in order to provide a proper environment for payloads and ultimately for personnel. These vehicles, when placed in the space environment are subjected to high vacuum, extreme temperature fluctuations, and severe solar and other extra-terrestrial radiation.

"Temperature control might be achieved by devices such as refrigeration-heating systems. These have not generally been used due to limited availability of power on vehicles. The alternate or passive system involves the use of mosaic surfaces consisting of the proper distribution of solar reflecting and absorbing areas which, in conjunction with internal heat conduction paths, permit reasonable temperature control of the vehicle.

"Coatings employed for this purpose must not only possess the desired absorbing or reflecting characteristics, but they must retain these characteristics over periods of months or years while in the space environment. In addition, they must retain their structural integrity and be chemically stable."

The new surface coatings which "reflect most of the solar radiation and emit strongly in the infrared region," provide the basis for one approach to a passive temperature control system for space vehicles, Mr. Sibert said.

Biochemistry Research

Capromycin, New Antibiotic

➤ A NEW antibiotic has been discovered which kills streptomycin-resistant TB germs in mice, a biochemist told the American Chemical Society.

In the animal experiments the new agent, called capromycin, was as potent as streptomycin or PAS, drugs commonly used against tuberculosis in human beings, and also was effective against the resistant organisms, according to Dr. Earl B. Herr Jr. of Eli Lilly and Company, Indianapolis. The new antibiotic is produced by a previously unidentified strain of microorganism called *Streptomyces capreolus,* it was reported.

After long treatment with a particular drug, the mycobacteria which cause tuberculosis are known to acquire immunity. Because of this resis tance to tuberculosis drugs, a potential new agent is of keen interest to doctors, the biochemist pointed out at a technical session of the ACS Division of Biological Chemistry.

Capromycin has a limited range of activity and is active primarily against mycobacteria, Dr. Herr continued. Absence of any cross-resistance between streptomycin and capromycin has been demonstrated both in the test tube and in the mouse, he said, adding:

"Mycobacteria gradually develop resistance to streptomycin when grown in a medium enriched with the antibiotic but remain sensitive to capromycin. Tests in a capromycin-enriched medium showed that resistance to the new antibiotic also develops gradually."

Clinical tests of capromycin are planned, according to the report. Michael E. Haney Jr. and Gail E. Pittenger, both Eli Lilly biochemists, were co-authors.

Asthma From Dust

➤ A HIGH incidence of asthma among University of Minnesota students may be related to two kinds of airborne dust particles isolated by a woman biochemist, she told the American Chemical Society.

Minute quantities of the materials, tested on allergic students, caused positive skin reactions, according to Velta Goppers, associate scientist at the University's school of public health. This indicates that the com-

pounds are of considerable biological significance and "may be one of the reasons for the occurrence of asthma," she said.

Collected at three testing stations on the campus, the particles have been partially identified and shown to be in a chemical class called polyglycoside peptides. During the course of the research Miss Goppers developed a new process for separating complex mixtures, based on a scientific technique called electrophoresis.

There is some evidence that the compounds "are parts of large molecules in nature which are degraded to a certain stage where they act as allergins," she reported at a session of the ACS Division of Analytical Chemistry.

The research, prompted by concern over the higher than normal incidence of asthma at the Twin Cities university and sponsored by a National Institutes of Health research grant, approaches the problem from two directions, Miss Goppers explained. It involves both medical studies of the students and environmental analysis of the area, which is surrounded by industry primarily involved in milling and malting of grain, animal food preparation, linseed and soybean production, and grain storage.

Students who have asthma and suffer asthmatic attacks receive treatment at the allergy clinic and are enrolled in the study group, Miss Goppers said, adding:

"The environmental study involves gathering data on weather parameters, determining the concentrations and composition of dust and gases, and studying the spread of the air contaminants through the campus area.

"The newly detected compounds both are found at all three testing stations in varying amounts during the summer and winter months.

"The work reported in my paper is an integral part of the research project, since we have been able to isolate and partially identify two compounds from a mixture of material extracted by solvents from a sample of airborne particles. Micro quantities of these two compounds, when skin tested on certain students, gave positive sensitization reactions. This indicates that these airborne compounds are allergenic and may be one of the reasons for the occurrence of asthma. We feel this is quite significant and have been encouraged to investigate further along these lines."

Dr. Harold J. Paulus, associate professor at the University of Minnesota School of Public Health, was co-author.

Chemical Test to Help Lengthen Life

➤ A CHEMICAL test may help extend life for a substantial proportion of the population, Dr. Herbert L. Davis of the University of Nebraska reported. Details of the test procedure were reported at the American Chemical Society's 140th national meeting.

The test measures the total fats in the blood stream. It is expected to provide a screening procedure for patients suspected of having arteriosclerosis and other disorders of di-

gestion and utilization of fats. Conspicuously high values in the test would justify further procedures to determine the separate kinds of fats present, he indicated.

The results will show the effects of exercise, reduced fats in the diet, substitution of polyunsaturated fats for the saturated ones and the use of various drugs.

It is hoped that screening for total lipids may become as common and as valuable as the X-ray test for tuberculosis.

Anti-Depression Drugs

➤ A NEW SERIES of compounds designed to combat mental depression without causing jitters, insomnia, or other bad effects was described at the American Chemical Society's 140th national meeting.

One of the agents produces a fourfold increase in the spontaneous activity of mice, according to Dr. Robert L. Clarke of Sterling-Winthrop Research Institute, Rensselaer, N. Y. This most potent member of the series, called "dl-threo-alpha-benzyl-N-ethyltetrahydrofurfurylamine," is now undergoing careful evaluation, the chemist said.

Normally, mice interrupted a light beam in their cage 250 times in a 30-minute period. When given minute doses of the new drug (16 milligrams per kilogram of body weight), the activity was increased to more than 1,000 interruptions in the same period. Stimulation was apparent at doses as low as one milligram per kilogram of body weight, Dr. Clarke told the ACS Division of Medicinal Chemistry.

"The treatment of mental depression at all levels from mild to psychotic has been a continuing problem for physicians," Dr. Clarke said. "Amphetamine, a central nervous system stimulant, has been widely used in these cases. Unfortunately, it causes side effects such as jitteryness, insomnia, tremors, increase in heart rate and elevated blood pressure.

"Amphetamine tends to cause overstimulation rather than acting as a simple antidepressant. Recently, monoamine oxidase inhibitors have been used as antidepressants, but they have already fallen into disrepute due to serious side effects such as liver damage. To date, electroshock therapy has remained the most effective treatment for depressed phychotic patients.

"In the course of general research at the Sterling-Winthrop Research Institute, directed toward development of drugs to fill such pressing needs as noted above, we encountered a series of benzyltetrahydrofurfurylamines which dramatically increased the spontaneous activity of mice.

"The most active stimulant of the series is *dl*-threo benzyl-N-ethyltetrahydrofurfurylamine. It is approximately twice as active as dl-amphetamine as a psychomotor stimulant in mice. This new drug is receiving a careful evaluation to determine whether it has desirable antidepressant properties without the side effects which have limited the use of earlier stimulants."

Dr. Louis S. Harris, also of Sterling-Winthrop, was coauthor of the paper.

Drug-Eating Organisms Aid Waste Disposal

➤ DRUG-EATING organisms are solving a serious disposal problem scientists were told at the American Chemical Society meeting.

The disposal of the liquid process wastes from the manufacture of antibiotics such as penicillin has created a major problem since World War II, Dr. Ross E. McKinney of the University of Kansas, said. The wastes are 20 to 40 times as concentrated as domestic sewage.

A new method has now been developed using microorganisms that can eliminate the wastes in a single stage process, Dr. McKinney reported. This is the first biological waste treatment process to be designed from the microbiological viewpoint, he said.

Previous methods using microorganisms, called activated sludge methods, did not have oxygen transfer equipment that could meet the oxygen demand in the aeration tank. The new process distributes the organic wastes over the entire aeration tank so that there is no high oxygen demand rate as in conventional activated sludge.

"Mathematical equations have been developed which permit accurate design of the complete mixing activated sludge systems. These equations permit the engineer to know what results to expect before the plant is put into operation and to evaluate operation problems which may arise," Dr. McKinney concluded.

Cancer Caused by Mistake of Virus

➤ CANCER MAY be a mistake of a virus, scientists were told at the American Chemical Society meeting.

A virus is a very complicated chemical compound with two parts: the nucleic acid, which has the reproducing information, and the protective coating, which is made of protein, Dr. M. P. Gordon, University of Washington, told the meeting. The nucleic acid of the virus is almost identical with the nucleic acid of the cell it infects, and the virus can fool the cell into using virus nucleic acid and reproducing virus, he said.

The deception does not always work, however, and the infected cell may produce defective and abnormal cells instead of viruses.

Scientists can now fool the virus, Dr. Gordon reported. They change the chemistry of the nucleic acid with similar chemicals, called analogs, and make the virus less effective. In some cases, the analogs prevent the virus from infecting the cell altogether.

When the analog of an amino acid, 5-fluorouracil, is incorporated into the simple plant virus, tobacco mosaic virus, the virus has difficulty infecting new cells and is more susceptible to certain chemical agents, Dr. Gordon said. The virus also becomes more

sensitive to the type of radiation used in tumor treatment.

"It is generally found that compounds incorporated into nucleic acids also inhibit the multiplication of viruses in infected tissues" Dr. Gordon continued. "They are often non-infectious or their ability to initiate infections and transfer genetic information to other cells is reduced. The genetic message carried by the virus is often garbled, resulting in mutants."

Nucleic acids that contain analogs are also more sensitive toward the action of a variety of physical and chemical treatments. This is the basis of cancer chemotherapy.

New Fluorine Anesthetic

➤ A NEW, non-flammable, inhalation anesthetic has been produced from a fluoride compound once considered too unstable to be of value, a Michigan chemist told the American Chemical Society.

The potent, long-lasting anesthetic reduces the need for post-operative narcotics and minimizes possibilities of overdosage, according to its discoverer, Dr. Eric R. Larsen of the Dow Chemical Company, Midland. It was developed by removing instability-causing by-products from methoxyflurane, chemically defined as (2,-2-dichloro-1, 1-difluoroethyl methyl ether), he said.

On long exposure to oxygen the new compound, unlike the impure material, does not form explosive peroxides. It is compatible with nearly all drugs commonly used in surgery and can be applied with conventional anesthesia apparatus without modifications or special attachments, Dr. Larsen told the ACS Division of Industrial and Engineering Chemistry.

First prepared in Great Britian in 1940, methoxyflurane, a halogenated ether, remained a laboratory curiosity because of the impurities which made it unstable. A method developed to remove the impurities provided a material with a shelf life of several years, Dr. Larsen said, commenting:

"Methoxyflurane is a non-flammable liquid having a pleasant, fruit-like odor. It is a potent anesthetic agent that produces profound relaxation of large muscles with minimal depression of the central nervous system. The new anesthetic is less apt than other halogenated inhalation anesthetics to cause sharp drop in blood pressure and unstable heart rhythm. Its low volatility practically eliminates the danger of accidental overdosage."

The research, stemming from the investigation of a wide variety of fluorine-containing compounds as potential inhalation anesthetics, was a joint project of Dow Chemical, Cornell University Medical College, and Abbott Laboratories, North Chicago.

CHEM EVALUATION 1960-61

This is the third in a series of articles concerning the progress being made in the Chemical Education Material Study or the CHEM Study. This investigation of the high school chemistry curriculum is supported by the National Science Foundation as is the Chemical Bond Approach Project at Earlham College. The CHEM Study has been reported in the January 1961 and March 1961 issues of CHEMISTRY.

THE MAJOR emphasis of the Study during its first six months of existence was to prepare a text and laboratory manual for use in the trial schools in 1960-61. This effort was successful.

The number of students involved in the twenty-four trial schools this year was about 1,300. The number in the same schools during the year 1961-62 will be around 3,000 and the total number of students using the material somewhere between 12,000 and 13,000 during 1961-62. It has been interesting to note the impressions of the teachers concerning the materials since they first saw it, approximately August 1, 1960.

At that time, it is safe to say each of the teachers was quite skeptical as to whether the material could successfully be handled by high school students. At the end of the four week session at Claremont, a considerable amount of this skepticism remained, and many teachers felt more firmly based in it. The fact that, after a year of use, each of them now desires to use the materials again, is perhaps some evidence concerning the feasibility of the program. All members of the staff, contributors, and participants agree that the first set of materials was far from perfect but feel that evidence of the first year has not only indicated areas that need most work, but has also shown that the general emphasis, content, and level are not unrealistic.

The second emphasis has been to acquaint as many people as possible with what the Study is doing, to keep them interested and providing the kind of information which would be a real contribution in planning the Study's progress, while at the same time being unable to allow them to use the materials in their own schools. Along this line, the staff has met with more than 5,000 teachers of science at professional meetings throughout the country.

A third emphasis has been to begin the preparation of motion pictures and other materials ancillary to the text and laboratory manual. Progress in these fields has been deliberately slow, to assure integration of films and materials with the text and the course. Film production, for example, is so expensive, making every effort to insure that the first films will set a high level of excellence towards which the rest can then be aimed: one which will allow potential users to have a real criterion as to the general contributions of films to the over-all program.

Now that they have established more definitive goals and areas of concentration they feel that they can proceed with plans for publication and presentation of a full course by the fall of 1963, the original goal of the Study.

Materials Revised

Immediately after the close of the school year last June, the trial teachers and contributors met with the staff at Berkeley for a three day session. Subgroups were assigned the task of evaluating and reappraising the textual materials in the trial edition. One of the main concerns was the excessive time spent last year on the overview section of the text. The following order of chapters for the text was agreed upon.

TITLES FOR CHAPTERS IN THE TEXT

1. Chemistry: An Experimental Science
2. Scientific Models and Atomic Theory
3. Atoms Combined in Substances
4. The Gas Phase: Kinetic Theory
5. Liquids and Solids
6. Chemistry and the Periodic Table
   Supplementary Reading — Geochemistry
7. Energy
8. Rates
9. Equilibrium
10. Ionic Solutions
11. Acids and Bases
12. Oxidation-Reduction
13. Stiochiometry
14. Believing in Atoms
15. Electrons and Periodic Table
16. Molecules in Gases
17. Bonding in Liquids and Gases
18. Carbon Chemistry
19. The Halogens
20. The Third Row
21. The Second Column
22. The Transition Elements
23. Biochemistry

The new schedule for the course calls for the following distribution of time:

1. Experimental Method — Chapter 1 2 weeks
2. Overview of Chemistry — Chapter 2-7 7 weeks
3. Chemical Reactions Principles — Chapters 7-13 11 weeks
4. Atomic Structure Chemical Bonds — Chapters 14-17 6 weeks
5. Descriptive Chemistry — Chapters 18-23 8 weeks

Volume I of the text contains the first six chapters and is ready for the opening of school this fall in some 125 trial schools. The laboratory experiments which accompany the first 13 chapters of the texts are included in Volume I of the laboratory manual and are listed below.

The complete set of materials including Volumes II and III of the text and Volume II of the laboratory manual will be available at a cost to all interested teachers in February 1962.

LIST OF EXPERIMENTS FOR THE FIRST SEMESTER

Experiment

Part I Observation and Interpretation — Precision of Measurement

1. Scientific Observation and Description

2. Observing Regularities
3. The Melting Point of a Pure Substance
4. Chemistry of a Candle
5. Heat Effects

Part II An Overview of Chemistry — The Mole Concept — Avogadro's Principle — Solutions

6. The Reaction of Solid Copper with a Solution of Silver Nitrate
7. The Empirical Formula of a Compound
8. The Formula of a Hydrate
9. Mass Relationships in a Chemical Reaction
10. Comparing the Weights of Gases
11. The Relation Between the Weight and Volume of Hydrogen
12. Some Aspects of Solubility
13. Reactions Between Ions in Solution

Part III Investigation of Chemical Reactions

14. A Study of Reactions
15. The Heat of Reaction
16. A Study of Reaction Rates I
17. A Study of Reaction Rates II
18. Applying Le Chatelier's Principle to Some Reversible Chemical Reactions
19. Chemical Equilibrium
20. The Heat of Some Acid Base Reactions
21. Indicators and the Determination of an Ionization Constant
22. A Quantitative Titration
23. An Introduction to Oxidation Reduction
24. Electrochemical Cells
25. Ionic Reactions

Appendix

A-1. Description of a Burning Candle
A-2. Laboratory Techniques
A-3. Measurement — Metric System
A-4. Some Mathematics Useful in Chemistry—Exponents, Adding Equations, Graphing Relationships
A-5. Precision in Measurement — Experimental Errors

Testing Program

In order to estimate the extent to which the new CHEM Study course got across to the group of students participating in the preliminary tryout, a series of five sequential achievement tests was developed and administered throughout the academic year 1960-61. Since these tests were developed and carefully reviewed by the senior editors of the textbook and laboratory manual, among others, they may be deemed to sample the kinds of learning consistent with the over all objectives of the CHEM Study course. In other words, they may be said to have a high degree of "content validity."

The data from these tests are reminiscent of the extraordinary findings in students in connection with the Physical Science Study Committee. As with the PSSC data the correlation of the CHEM Study achievement test scores with those on the aptitude test are inordinately low as compared with similar correlations of aptitude against the multitude of traditional achievement tests in high school chemistry.

In summary, it can be stated with positive assurance that, given a group of students such as those who were enrolled in the CHEM Study Course during 1960-61 and teachers of equal caliber, the course most certainly would produce equally dramatic results. During the coming academic year a much larger, and presumably more representative group of students will be using the course materials that were revised during the summer of 1961. Hopefully the results based on this more representative group will prove to be as significant and promising as those of the students who participated in the original tryout.

Highlights from the Fifth International Congress on Biochemistry at Moscow in August

Key Biochemical Machine

➤ A FULL account of an eight-year study of the mitochondrion — a key biochemical machine that is the principal energy provider of all oxygen-using cells — was given by Dr. D. E. Green, University of Wisconsin professor.

When enlarged a million times, the mitochondrion looks like an elongated cake in which large numbers of raisins are embedded in regular array, Dr. Green told the International Congress of Biochemistry.

The raisins are the elements that do the work of the mitochondrion, and the cake is the structural network in which the raisins are mounted and supported.

"Each raisin," Prof. Green said, "is known as the elementary particle, which is the complete functional unit. There are some 17,000 such units in a single mitochondrion of beef heart."

These particles carry out the complete oxidation of pyruvic acid (an acid normally produced in the body during a stage in the breaking down of carbohydrates or proteins) to carbon dioxide and water. During this combustion process, energy of oxidation is converted to chemical energy that is stored in the chemical, adenosine triphosphate or ATP.

Prof. Green said that in the structural arrangement he described as raisins in a cake, the raisins differ from one biochemical machine to another but the cakes in which these particles are embedded are much the same in design and arrangement.

"Two elements make up the cake," he said, explaining that a special protein known as the structural protein, which is a huge polymer (a long molecule), is inextricably tied up with lipid. The biochemical raisins are imbedded within this matrix of structural protein and lipid, and the matrix serves to keep the functional elements in just the right shape and posture to do their work properly.

Prof. Green said "the elementary particle has a kind of bucket brigade for moving electrons from pyruvic acid to oxygen," which is a basic step in the oxidation of sugar. At least 11 different components are lined up in sequence to make up this chain.

"If we think of the oxidation of pyruvic acid as the transfer of electrons from pyruvic acid through the chain and finally to oxygen," he said "then in the passage of a pair of electrons through this chain, three

molecules of inorganic phosphate are converted to the terminal phosphate groups of ATP."

Some of the most important biochemicals have a place of honor on this chain, Prof. Green said. They include flavin, one of the B vitamins, the active component of red blood cells; iron in a form other than heme iron; copper, and a newly discovered benzoquinone called coenzyme Q.

Chemical "Brain" DNA

➤ THE CHEMICAL "brain' of a virus that orders the creation of more viruses has been isolated for the first time. It is not like a real brain, but is the chemical unit that gives instructions for formation of another virus.

The chemical is deoxyribonucleic acid, or DNA. It is a double-strand "brain," shaped like two intertwined corkscrews, and can be isolated from the virus and transplanted into a new host cell where it begins to function again.

The discovery gives scientists a system that they can control in their search for clues to the basic genetic code governing the production of living cells. It was reported to the Fifth International Congress on Biochemistry.

Drs. Earl Evans Jr., Roy P. Mackal and Franz Meyer, all of the University of Chicago, have shown for the first time that DNA by itself can command a complete new cell. The "assistance" of proteins or ribonucleic acid is not necessary.

DNA is thus shown to be identical with the genetic matter of the cell. It was isolated from the virus known as lambda. Examination of the chemical properties of the lambda DNA shows that it resembles those of the DNA found in the genes of living cells in possessing double helical structure.

"This is the first time that a DNA having a double helical structure has been shown to be infectious," the biochemists said.

Before any major claims can be made for the code-breaking capability of the double-stranded lambda virus DNA, attempts must be made to do the "deciphering job," they said. Theoretically, with each variation that is made in the test tube in DNA's chemical structure, a similar change will result in the type of protein manufactured.

They said the laboratory work took advantage of the knowledge that the lambda "languishes inside an intestinal bacillus of man in another chemical form, called a 'provirus'."

New Technique Discovered

➤ AN IMPORTANT tool is seen in the discovery of a new technique for separating and measuring the sub-units of large protein molecules.

Dr. Francis J. Reithel, head of the University of Oregon chemistry department, reported his new technique at the Fifth International Congress on

Biochemistry. Up to now geneticists have had to use small protein molecules, which are not numerous. Separation of the sub-units of large molecules will give access to a larger number of molecules for this research.

The new technique involves dissolving purified proteins in a chemical reagent known as guanidine hydrochloride. Dr. Reithel uses an ultracentrifuge, a refined version of apparatus that separates material by rotation.

To separate the sub-units, Dr. Reithel used a technique called sedimentation equilibrium, in which diffusion of the molecules offsets centrifugation. The molecular weights are determined from readings on photographs, taken while the ultracentrifuge is in motion.

Ordinarily the sedimentation equilibrium process takes days, but by using a very short column of one millimeter or less of protein solution in the ultracentrifuge the experiments were reduced to a few hours. This use of a short column is less than two years old.

For his protein material Dr. Reithel uses enzymes, a class of organic substances that accelerate specific transformations in living cells. Dr. Reithel produced a pure form of an enzyme called betagalactosidase, which comes from a common intestinal bacterium.

This enzyme appeared to have a molecular weight of 700,000, but it also showed evidence of having smaller functional units. Preliminary observation indicates a molecular weight of 35,000 for each of 20 sub-units.

Dr. Reithel said the analytical technique of combining the short column, sedimentation equilibrium method with the use of guanidine hydrochloride is a very convenient and powerful tool for determinating molecular weights on very small quantities of material. He is now studying methods for preventing the separated sub-units from rejoining.

Tranquilizer Affects Enzyme

➤ Phenothiazine tranquilizers, used to depress the central nervous system and induce sleep, may be producing their effects by speeding the action of an enzyme in the brain, five biochemists from the University of Nebraska Hospital, Omaha, reported.

The effect of this particular group of compounds was described as "the most striking" observed in a general study of what tranquilizing agents do to enzymes, the catalysts that increase the rate of chemical reactions in cells.

Phenothiazine drugs were shown to step up the activity of a brain enzyme called L-glutamic decarboxylase. The enzyme changes glutamic acid to gamma-aminobutyric acid, which inhibits the functions of the central nervous system.

Dr. Herbert P. Jacobi, Dr. David Rosenberg, Dr. M. J. Carver, John Haggstrom and Martha Kelly, of

the University's biochemistry department, made their announcement at the International Congress of Biochemistry.

Their study is based on the theory that the body's chemical processes are based on enzyme activity, and that the chief action of drugs to treat diseases is one of interference with enzymes.

Information on drug-enzyme interaction is expected to give new insight on disease causes, as well as to help determine what drugs should be prescribed for varying types of ailments.

Controversial Theory Proposed

➤ A CONTROVERSIAL theory of how insulin controls diabetes was described by a University of Maryland professor at the Fifth International Congress on Biochemistry.

How insulin actually works in the body has never been clarified despite successful isolation of the hormone from pancreatic tissue for control of diabetes some 40 years ago, Dr. Samuel P. Bessman of the University's School of Medicine, Baltimore, said. The body hormone, which is necessary to prevent diabetes, affects the absorption of sugar but equally affects the production of starches and fats.

Dr. Bessman discussed the relationship of his own findings to the broader problems of protein synthesis and the release of cellular energy in the body. He believes that insulin may act as a "metabolic clutch" in releasing energy within living cells.

His theory is that insulin binds trypotophan, a protein building block, to muscle protein. It acts, he believes, to connect mitochondria to the enzyme in the cell. By making the mitochondria more efficient, the insulin gives all cells a boost.

Mitochondria are little particles in the cell that generate energy in usable form as metabolic fuel. They are a mobile power unit, but they have to be near to what they give power. A special enzyme in the cell is needed to get the particles operating.

This enzyme is usually free in the cell, and it is Dr. Bessman's theory that insulin connects this enzyme to the mitochondria.

Early Earth's Surface

➤ THE EARTH'S surface in its early years of life may have glowed like a beautiful rainbow, shimmering with the colorful array of light emitted by primitive organisms.

Light emission may have occurred soon after life appeared on earth, when the atmosphere lacked oxygen, Drs. W. D. McElroy and H. H. Seliger of Johns Hopkins University, Baltimore, Md., reported at the International Congress of Biochemistry.

In removing the oxygen by the use of organic reducing substances, an excited state was produced resulting in the emission of light. The surviving

organisms were therefore all potentially luminescent. Thus began the oxygen-using metabolism evident in most present day organisms.

After the aerobic system became well established the luminescent systems no longer had a selective advantage. Nevertheless they continued to exist and are now found in certain bacteria, fungi and the firefly.

The compound that makes the firefly glow, luciferin, was recently synthesized for the first time by Dr. McElroy and three other scientists at Johns Hopkins University. The firefly's luminescent system was adapted for a secondary purpose, the identification of the female firefly by the male.

As small amounts of oxygen appeared in the atmosphere, not all of the organisms could tolerate the presence of oxygen. However, those that could quickly and rapidly remove the oxygen by reduction with hydrogen or electrons from primitive foodstuffs survived.

Body Fights Foreign Protein

➤ NEW FACTS reported at the Fifth International Congress on Biochemistry indicate that the reaction of the body to foreign proteins is chiefly the reaction of general rather than specific cells within the body.

The reaction to foreign protein, of which some allergies are examples, is actually a build-up of antibodies to any foreign protein, also known as an antigen.

Dr. F. Haurowitz of Indiana University, Bloomington, working with M. Richter and S. Zimmerman, reported that, contrary to popular belief, antibody production does not stop after the first injection of an antigen. Even after a single injection, antibody production continues in rabbits for more than a year.

The second injection causes immediate formation of antigen-antibody complexes and these complexes act as a strong stimulus for the antibody-forming cells. The antibody content of the blood then increases rapidly.

The findings are in opposition to the theory proposed by the Australian Nobelist, Sir F. Macfarlane Burnet, that the body has built-in cell types and that each type can maunfacture antibodies of only one type. When antigen A is injected, those cells that form anti-A will be stimulated to excessive growth and multiplication, the theory states.

This theory does not explain how the body can react against unnatural proteins manufactured by chemists, but not found anywhere as natural substances. Presumably the body would have cells prepared to deal only with naturally occurring substances.

The explanation proposed by the scientists indicates that the antibody-forming type of cell has the ability to form antibodies against any type of antigen, not just one.

Sulfa Tricks Enzymes

▶ SULFA DRUGS can fight human infections because enzymes are tricked into using them instead of a specific acid.

Dr. Gene M. Brown of Massachusetts Institute of Technology told the Fifth International Congress on Biochemistry that a large part of sulfonamide and a small amount of para-aminobenzoic acid means the formation of very little folic acid, and thus little chance of bacterial growth.

In the 20 years during which sulfa drugs have been in use, scientists and physicians have not been able to pinpoint just why they were so effective.

The chemical properties of sulfonamides and para-aminobenzoic acid are so similar that it is possible to fool the enzymes, which are the "mechanics" of bacterial growth, into using them in place of the acid.

Sulfonamides are not toxic to animals, which do not manufacture the vitamin folic acid, but the animals are continually in need of a dietary supply of the acid. Sulfa drugs or compounds fed to an animal do not affect the animal directly, but do prevent the growth of infection-causing bacteria by "inhibiting the enzymatic formation of folic acid by these bacteria."

Photosynthetic Process Less Simple

▶ PHOTOSYNTHESIS — the conversion of light into energy by living cells — is not as simple as that observed in green plants.

By isolating the photosynthetic process from the complex living cell, scientists have found that the process is independent of oxygen and more closely linked with absorbing phosphorus. Scientists normally view photosynthesis in plants as converting carbon dioxide to sugars while giving off oxygen to the air.

Photosynthetic cells are distinguished from other cells by their ability to form two products from light energy, ATP (adenosine triphosphate) and PNH-2 (reduced pyridine nucleotide). The formation of these products is largely responsible for converting carbon dioxide to sugars. The reaction is accompanied by the evolution of oxygen, which to the casual observer seems to require more light energy.

It is these outward reactions that have resulted in the popular definition of photosynthesis.

University of California scientists in Berkeley carried on cell-free photosynthetic experiments by removing chloroplasts from spinach leaves. Chloroplasts are tiny particles of green leaves that contain the chlorophyll pigments where photosynthesis takes place.

The results of the experiments were presented to the International Congress of Biochemistry by University of California professor, Dr. Daniel I. Arnon.

Proudly Presented

Announcing new developments in the chemical industry and newly available chemical literature.

Static Electricity

➤ A NEW chemical that eliminates static electricity has freed record collectors from becoming dust collectors.

The new anti-static agent, developed and produced by American Cyanamid Company under the trade name Catanac SN, is being used by RCA Victor as an additive in its record mix.

George R. Marek, vice president and general manager of RCA's Record Division, said recently that the solution of the dust problem is "one of the greatest technical advances in recording in a decade."

Static electricity attracts dust to the surface of phonograph records which, in turn, results in a high-pitched scratch that interferes with perfect reproduction of sound. The more sensitive your recording equipment is, the more annoying the dust interference.

RCA's search for an efficient anti-static agent began more than 10 years ago, but the problem was solved only when scientists at American Cyanamid Company's laboratories in Stamford, Conn. discovered that Catanac SN made an excellent anti-static agent when added to the record mix. The chemical had been previously used as an emulsifier to mix such different liquids as oil and water and as a detergent to separate soil particles from cloth.

Further tests have proved that Catanac SN also eliminates surface charges of static electricity in paper, plastics, textiles and many other materials. It has also made possible the development of furniture polishes which leave a dust-repelling surface and fabrics which do not attract lint and dirt.

In addition to using Catanac SN as the standard anti-static agent for all of its stereophonic records produced in the United States, RCA's Custom Sales department has also offered its use to many independent record manufacturers for stereophonic long-playing record production.

Space-Age Fabric

➤ A NEW space-age clothing material developed to protect personnel manufacturing and handling missile fuels is expected also to play a useful safety role throughout industry.

Developed by Du Pont and tested by the military, the material is known as "Armalon" fluorocarbon laminated fabric 97-00-A. It consists of aluminized "Teflon" FEP-fluorocarbon film laminated to a fabric made of "Teflon" TFE-fluorocarbon fiber. Government agency tests report this new type of "Armalon" is more resistant to all chemicals tested, including gaseous fluorine, chlorine trifluoride, and pentaborane, than any suitable fabric constructions yet evaluated.

So new that manufacture of protective garments for those working with high energy fuels is just beginning, "Armalon," according to the Du Pont industrial fabrics development group, should soon find a place in lines of

standard industrial safety and protective equipment, including outerwear, gloves, aprons, and the like.

"Armalon" 97-001A is manufactured under U. S. Patent 2,773,781, issued to the Du Pont Company. It is made at the company's Fairfield, Conn., plant, and is available at $69 per yard in 24-inch widths.

Where protection against flash fires is not required, the film-to-cloth laminate is available without the reflective aluminized coating. This quality is designated 97-001 and is priced at $59 per linear yard.

Data sheet and swatch sample may be obtained by writing Room WT-902, Du Pont Company, Wilminton 98, Del.

Acids and Anhydrides

➤ A NEW 48-page booklet, describing the properties and uses of organic acids and anhydrides, has just been published by Union Carbide Chemicals Company.

The booklet contains comprehensive data on acetic, propionic, butyric, 2-ethylbutyric, 2-ethylhexoic, acrylic, sorbic, valeric, and isodecanoic acids; acetic, propionic, and butyric anhydrides.

Included is information on physical properties; constant-boiling mixtures; specification limits; test methods; storage, handling, and shipping; toxicological properties; and selected literature references.

Organic acids are used mainly as intermediates and acidifying agents while the anhydrides find their main application in the formation of esters under conditions where no reaction would take place with the corresponding acid.

One or more of the acids, or their derivatives, can be used as solvents; esterifying, acidifying, and neutralizing agents; extractants; epoxidizing agents; gasoline sweetners, oil-well fracturing agents; wood impregnants; soil conditioners; corrosion inhibitors; and in the manufacture of insecticides ,food preservatives, fungicides, pharmaceuticals, plasticizers, thermoplastic and thermosetting resins, adhesives, textile finishes, herbicides, flavors, perfumes, lubricants, dyestuffs, varnish and enamel driers, cosmetics, surface coatings, detergents, emulsifiers, floor polishes, foundry core and mold binders, gasoline additives, resin modifiers and stabilizers, rubber-processing and compounding chemicals, and other applications.

Anhydrides are of special interest for treatment of petroleum and food oils; in the manufacture of acetate fibers, plastics, coatings, films, cellulose esters, pharmaceuticals, brake fluids, edible fats and oils, plasticizers, perfumes and odorants, flavors, polymerization catalysts, fly baits, explosives, weed killers, dyestuffs, fungicides, and fire-resistant paper and textiles.

Liquid Neopreme Coating

➤ DEVELOPMENT of a new, improved liquid neoprene protective coating is announced by Adhesive Products Corporation, 1660 Boone Avenue, New York 60, New York. Designated APCO Liquid Neoprene Coating, it is DuPont neoprene rubber in an easy-to-use liquid form, which can be applied by brush or paint roller. APCO dries in minutes, forming a continuous rubber film on metal, wood, plastic, concrete and other surfaces, which is impervious to fresh and salt water,

oils, gasoline, naptha, acids and alkalies and other chemicals.

It is permanently flexible and will not peel, blister or crack under changing climatic conditions. It offers prolonged protection against rust, mildew, fungus, sunlight and humidity, and is ideal for protecting and weatherproofing a wide variety of materials.

It is recommended for boats, outdoor furniture, metal fences and railings, garden tools, tarpaulins, tents, tractors, machinery and equipment. It is ideal for repairing and waterproofing leaking roofs, chimney flashings and pipe joints; rust-proofing metal cabinets and trash cans; coating drains, ducts, garden hoses and tents; protecting darkroom equipment; and insulating and rust-proofing air conditioners. APCO will also find wide use in plant maintenance and in skid-proofing floors, ladders and other surfaces.

APCO Liquid Neoprene Coating is available in pint, quart, one-gallon and five-gallon cans and in 55-gallon drums. The material has a shelf life of more than twelve months when stored in a sealed container.

Teflon Filaments

➤ MONOFILAMENTS made of "Teflon" FEP-fluorocarbon resin are under study by a filaments marketing section of Du Pont's Polychemicals Department for possible use in brush applications where problems result from contact with acids and chemicals.

Because of the stable, anti-frictional characteristics of "Teflon," monofilaments of the FEP-fluorocarbon may provide a premium bristling material for brushes which face exposure to corrosive elements, extreme temperatures and sticky ingredients.

Inert to virtually all industrial chemicals and solvents, "Teflon" resins retain their effectiveness at extremely low temperature, have the lowest coefficient of friction of any known materials, and are flame resistant.

Brushes containing FEP monofilaments for use in chemical and petroleum laboratories, photoengraving plants and other areas with cleaning and brushing problems related to acids and chemicals are prime market possibilities.

"Teflon" FEP monofilaments are available in diameters of five and 11 mils, but other sizes can be supplied for developmental purposes. P. J. Wayne, Polychemicals Department, Du Pont Company, Wilmington 98, Del., is in charge of the program.

N-Butyl Alcohol Bulletin

➤ A REVISED and greatly expanded data bulletin on n-butyl alcohol has just been released by U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation.

This 12-page bulletin contains U.S.I. specifications for n-butyl alcohol in addition to resin solubilities, chemical references. A large section on physical properties is included, as well as an extensive list of binary and ternary azeotropes.

U.S.I.'s new bulletin is specifically designed to provide information on n-butyl alcohol for the surface coatings and chemical processing industries. Copies are available from Technical Literature Department, U.S. Industrial Chemicals Co., 99 Park Avenue, New York 17, N. Y.

Silicones for Electrical Insulation

➤ A NEW eight-page two-color publication, "Silicones for Electical Insulation," is available from the Silicone Products Department of General Electric, Waterford, New York.

Designated CDS-288, the publication is complete with more than 20 photographs and charts providing valuable data and examples of silicones in use in a wide variety of electrical and electronic applications.

Included are sections on silicone varnishes for impregnating and protective coatings, clear and opaque potting and encapsulating materials, pressure sensitive adhesives, dielectric fluids, dielectric greases, wire and cable insulation and combination constructions of silicones with other materials. Also shown are some of the General Electric testing facilities which are available for development of new products and applications and the solution of complex customer problems.

The publication is available upon written request.

Food-Grade Triethylene Glycol

➤ AVAILABILITY in commercial quantities of high-purity triethylene glycol, recently cleared by Food and Drug Administration for use in food packaging materials, has been announced by The Dow Chemical Company, Midland, Michigan.

Dow said the premium grade meeting FDA conditions of less than 0.1 per cent of diethylene glycol has a wide range of applications as a plasticizer or humectant in cellulosic food packaging materials, and in cork seals for bottled foodstuffs and beverages.

The FDA regulation published in THE FEDERAL REGISTER lists two conditions of use: that the food additive contain less than 0.1 per cent of diethylene glycol; it is used or intended for use as a plasticizer in cellulosic food-packaging materials.

Dow will market the product under the name triethylene glycol HP (high purity) at a premium price 1½ cents a pound above technical grade prices currently 18½ cents a pound in the eastern freight zone and 19½ cents a pound in the western zone in tank car quantities.

Polypropylene

➤ PROPERTIES and characteristics of Tenite polypropylene are described in Materials Bulletin No. 9, issued by Eastman Chemical Products, Inc.

Capable of being injection molded or extruded on the same equipment used for other thermoplastics, the newest addition to the Tenite family of plastics is said to possess exceptional moldability qualities, particularly apparent in difficult-to-fill mold patterns. Other properties attributed to Tenite polypropylene are its low density, its high stiffness in flexure, and excellent resistance to heat, impact, stress-cracking and chemical attack.

Three tables appended to the bulletin present technical data covering (1) the resistance of Tenite polypropylene to chemical; (2) typical physical properties of the plastic in injection molding; and (3) suggested formulas for various methods of processing.

Materials Bulletin No. 9 is available on request from the plastics division, Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Co., Kingsport, Tennessee.

Color-Coded Pipets

➤ A COMPLETE line of pipets which are color-coded for ease of identification has been introduced by Corning Glass Works.

The Pyrex brand blass pipets are coded by bands of color according to capacity and graduated interval. In addition, the capacity is printed in matching colors above the bands.

The line features a new size pipet with a capacity of 5/10 ml. graduated in 5/100 ml. intervals.

According to Corning, over 70 types and sizes of pipets make up the color-coded line, including the Mohr measuring type, long tip measuring and serological types, taper top, cotton mouth and large tip opening measuring and serological types.

Color-coding is available on pipets with regular Pyrex brand white-filled, lifetime red or accu-red markings.

The color-code is located opposite the regular pipet inscription.

The bands and numbers are silk-screened and permanently fired onto the glass. The color meets the chemical durability standards set by federal specification DD-V-581-a.

The pipets are made of hard, low-expansion borosilicate glass, noted for its chemical durability. The cost of the new color-coded pipets is the same as the regular Pyrex brand pipets.

Stabilized Methyl Parathion

➤ VICTOR CHEMICAL WORKS, Division of Stauffer Chemical Company, has developed a new, stabilized form of methyl parathion. It is now being introduced on a national basis under the trade name Stabilized T-80 methyl parathion.

The new product offers several significant advantages to formulators. Because it has a full 80% concentration, less material need be sprayed on absorbent carriers which, in turn, yields drier, more free-flowing dust bases. Such formulated dusts also contain less solvent so that weight loss through evaporation is reduced. Moreover, the higher concentration of the toxicant reduces spray time and thereby minimizes labor costs.

Extensive laboratory and field tests have established that dust formulations of the new product are stable over a wide range of conditions. Stabilized T-80 methyl parathion is resistant to heat and hydrolysis and also to the catalytic degradation which results from contact with certain types of clays and absorbents.

An 8-page research report on this new product is available from the Victor Division Sales office in Chicago. Samples are also available from the same source, but because of its toxicity require special arrangements.

Victor will warehouse Stabilized T-80 methyl parathion at all regular methyl parathion stock points.

New Copolymers

➤ ANTARA CHEMICALS, a Division of General Aniline & Film Corporation, New York, announces the first three products in a new series of water-emulsion copolymers of vinylpyrrolidone. They will be available initially in development quantities only and will be marketed under the registered trademark "POLECTRON." This series represents the Company's first entry into water-emulsion polymers.

The first three products in this new group will be called Polectron 130 — which is a vinylpyrrolidone/ethyl

acrylate copolymer emulsion; Polectron 430 — a vinylpyrrolidone/styrene copolymer emulsion; and Polectron 450 — another vinylpyrrolidone/styrene copolymer emulsion. Each has a 40% solids content.

The features of the Polectron series open up new possibilities for water-emulsion polymers in that they offer dye receptivity, unusual emulsion stability, excellent adhesive properties, and unique film-forming properties.

Some of the applications for these new products will be in the adhesives field, where they will bond diverse materials to each other. Additional adhesives uses will be found in textile coating, paper coatings, and glass fiber sizes. The superior dye receptivity exhibited by these products will make them highly desirable as nonwoven fiber binders and latex rug backings. Since these new film formers, in addition to their adhesion properties also show great toughness, evaluation as surface coatings — particularly as metal primers and top coatings for wood — is indicated. They have considerable potential, furthermore, as acid-stable detergent opacifiers and as aerosol starch resins.

Some of the properties inherent in these new emulsion polymers are due to their vinylpyrrolidone content. These products have excellent freeze-thaw stability, shear stability, acid and salt tolerance. They can be cross-linked by exposure to temperatures of 100° C or higher for one-half to one hour.

All three of the first Polectron copolymers are insoluble in the following solvents: water, ethyl alcohol, ethyl acetate, acetone, methyl ethyl ketone, benzene, carbon tetrachloride, heptane, and dioxane. Exceptions will be found in Polectron 430 which is partly soluble in benzene and Polectron 450 which is partly soluble in water.

While currently available in development quantities only, Antara Chemicals intends to make tank car quantities available before the end of 1961 at reduced prices.

Additional information may be obtained from The Acetylene Chemicals Department, Antara Chemicals, a Division of General Aniline & Film Corporation, 435 Hudson Street, New York 14, New York.

Drinking Water Standards

▸ Radioactivity concentrations in drinking water have been limited by the U. S. Public Health Service for the first time.

Dr. Luther L. Terry, PHS Surgeon General, said the radioactivity limits were three micro microcuries per liter for radium-226; 10 micro microcuries per liter for strontium-90; and 1,000 micro microcuries per liter for gross beta activity.

This the the first time in 15 years (since 1946) that drinking water standards have been revised. The standards form the basis for legally regulating the drinking water used on trains, airplanes, buses and vessels in interstate commerce.

In the revised standards, requirements for water quality were generally raised. Few changes were made in bacteriological standards, but limits for certain chemical pollutants were added for the first time.

For the Home Lab

Anthraquinone

by Burton L. Hawk

➤ Anthraquinone is an important material for the manufacture of many dyes of the alizarin, anthracene and anthraquinone groups. Alizarin is the most popular of these dyes and carries the distinction of being the first naturally occurring dyestuff to be synthesized in the laboratory. It is prepared from a derivative of anthraquinone — sodium B-anthraquinonesulfonate, commonly known as "silver salt."

The starting material for all of these dyes is *anthracene* which, in turn, is obtained from coal tar. Practically all the anthracene obtained from coal tar is converted to anthraquinone and its derivatives. However, now anthraquinone is produced from phthalic anhydride and benzene and oddly enough, anthracene of high purity can be obtained from synthetic anthraquinone by distillation with zinc dust. This leaves poor anthracene more or less out on the limb. Such are the vicissitudes of chemistry!

Anthracene

In the home laboratory it is most practical to use anthracene as the starting point. You will need material of high purity (M.P. 215-217 deg. C.). Place 50 cc. of glacial acetic acid in a large beaker. Heat the acid until it starts to boil. Then sift in one gram of powdered anthracene. (If your anthracene is crystalline, powder it first in a mortar.) Continue boiling the acid until the anthracene is dissolved.

While this is going on, dissolve four grams of potassium dichromate in the smallest possible quantity of water and set it aside. After the anthracene is dissolved in the acid, remove the heat and immediately add 3 cc. of concentrated sulfuric acid. Follow this by the addition of the potassium dichromate solution, drop by drop. (Do not add more than a few drops at a time.) A vigorous action takes place and the solution turns dark green. After all the dichromate solution has been added, boil the solution again for five minutes. Remove from the heat, add about 50 cc. of water and stir. The anthraquinone separates out of solution. Stir, and then filter the solution. Remove the precipitate by scraping it carefully from the filter paper into a beaker.

Test Product

Now, before proceeding further, suppose we test our anthraquinone. Prepare a solution of sodium hydroxide and pour a small quantity in a test tube. Add a little of the crude anthraquinone just prepared along with a small amount of zinc dust. Shake, and heat the mixture gently. Note the liquid starts to turn red. Stop heating at this point and filter. The blood-red color of the filtrate is due to the disodium salt of anthraquinol. Let it stand for a while and you note that the red color gradually disappears and a precipitate of anthraquinone is formed.

Anthraquinone is moderately soluble in chloroform. Add about 100 cc. of chloroform to the crude product you have prepared. Stir thoroughly for a few minutes; then filter. Pour the filtrate in a shallow dish and set it aside in a warm place. The chloroform will evaporate leaving the anthraquinone behind. When it is thoroughly dry, scrape it from the dish and transfer it to a vial or small bottle. Stopper it tightly and label it. Perhaps we will be able to make use of it later on to prepare a dye.

The product as obtained in this manner is a light yellow-green powder. If you desire, it can be further purified by sublimation. The powder is poured into a shallow evaporating dish. Cover the dish with a piece of filter paper which has been perforated with a number of tiny holes (use a pin or small nail for this purpose). Place an inverted watch glass (or an inverted glass funnel) carefully on top of the paper. Set the whole on a wire gauze and apply a very small flame. After a short while light yellow crystals will be deposited on the cool upper watch glass or funnel. The filter paper will prevent them from falling into the exaporating dish below. Remove the heat and carefully scrape the crystals off.

As stated above, anthraquinone is converted into anthracene by distillation with zinc dust. It yields various products on sulfonation, the most important of which is the "silver salt," also mentioned above. It is reduced with alkali and zinc dust, as we have demonstrated, to form the disodium salt of 9,10-dihydroxanthracene (or 9,10-anthradiol). It is quite resistant to oxidation and halogenation is impracticable.

By far the most important use of anthraquinone is as a dye intermediate. However, it does have one other use . . . a rather unusual one: it is used in treating seeds because it makes them distasteful to birds!

On the Back Cover

➤ THE BACK COVER *shows missile-shaped Melter-Washer Tower of new salt water conversion plant at St. Petersburg, Florida. Plant is on Weedon Island in Tampa Bay. The plant is one of a series of saline conversion plants sponsored by the Office of Saline Water. It utilizes a freezing process system developed by Dr. H. F. Wegandt of Cornell University and the Blaw-Knox Company of Pittsburgh, Pa.*

Designed to produce ice crystals — which are pure water — salt water and liquid butane are pumped into either the tower at the left or a rotating basket device being insulated in photo. As the butane turns to a gas, it pulls heat from the salt water, creating a slurry of ice in the brine. The brine is next drained from the slurry and the ice crystals washed clear of any remaining salt water. The ice then moves to a melter unit where the heat throw-off from butane gas under pressure causes it to melt. Potable water is sent to storage tanks and the brine dumped back in Tampa Bay. Daily production of 35,000 gallons is expected.

√ *Chemistry Quiz* √

Directions: Mark the answer you think *most nearly correct.*
Answers are on page 39.

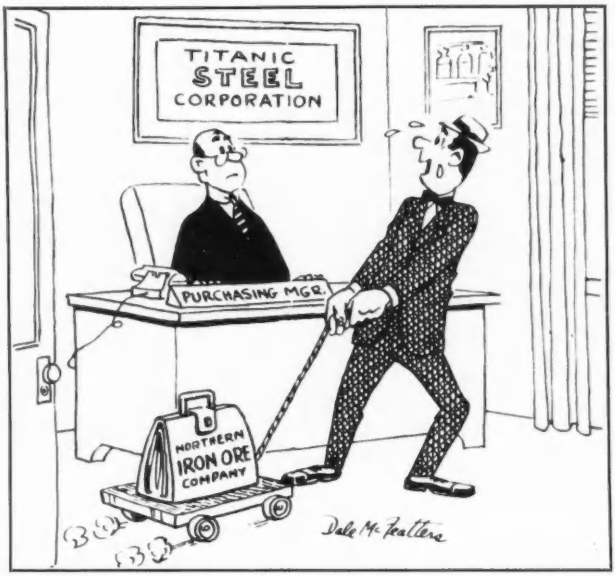
A. Isobutane and n-butane are
1. isotopes
2. isobars
3. isotherms
4. isomers

B. In the electroplating process the object to be plated is used as the
1. anode
2. electrolyte
3. cathode
4. anemometer

C. Which of the following minerals do not contain calcium?
1. apatite
2. quartz
3. calcite
4. vermiculite

D. Which of the following is not a sugar?
1. glucose
2. sucrose
3. lactose
4. saccharin

E. The total number of electrons in the atomic structure of fermium is
1. 100
2. 255
3. 155
4. 55



"Good morning, sir. I represent Northern Iron Ore!"

Abbott

This article continues the series began during the last volume in CHEMISTRY. This series features the major companies employing chemists in the United States. Many of the students now preparing for a career in chemistry will eventually join one or other of the large corporations. This series is intended as a preview into the type work that they will be doing.

➤ SPOT, A DOG with high blood pressure, jogs into the research laboratory, hops up onto a small table and lies down relaxed while electrocardiograph and blood pressure readings are taken — readings that show possible cardiovascular actions of an experimental drug. In another laboratory, a microbiologist takes a small sample of soil and dilutes it with sterile water, preparatory to isolating microorganisms from it — one of which *may* produce a new life-saving antibiotic. A cell physiologist peers through a microscope while he inserts microelectrodes into an isolated living cell in a tissue culture — the electrical response of the cell gives him clues as to the effect of a new drug on the cell itself.

These are among the activities you might see if you were to tour the Research Center at Abbott Laboratories in North Chicago, Illinois. There hundreds of scientists are at work seeking to discover and develop new drugs for humans and animals and new chemicals for industry and agriculture.

Among the projects toward which they're directing their efforts are infectious diseases (including the common cold), diseases of the heart and circulatory system, the nervous system, metabolism, endocrinology, allergy and nutrition. A few miles from the main plant and research center in North Chicago is a 300-acre research farm that plays an important part in yet another activity — the development of new animal health products. A third aspect of the Abbott scientific effort is research on new industrial chemical products.

Research Center

Center of many of these activities is an eight-story, gleaming glass and aluminum research building dedicated in 1961 that doubled the space previously available to the Abbott scientific division.

This research has advanced rapidly in the last decade and a half. At the close of World War II, Abbott's scientific personnel numbered 150 and its research budget a little more than $1 million. Now that staff has more than 800 members and the company's research expenditures for 1961 will exceed $9 million.

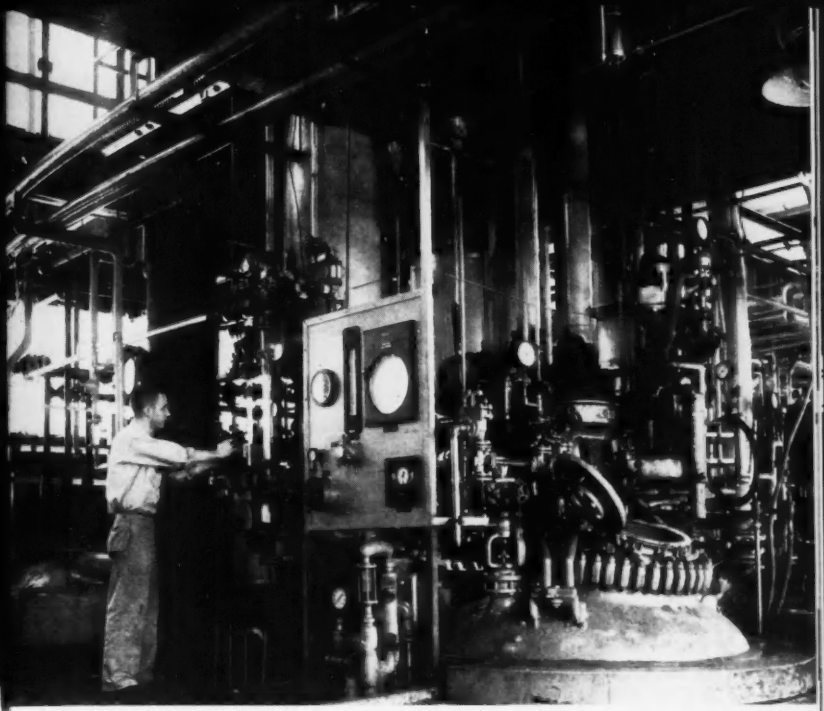
However, to make major advances against organic diseases like heart and circulatory disorders, mental illness,

➤ NEW RESEARCH *center addition at Abbott Laboratories provides 225,000 square feet of space with the most modern equipment for research in the life sciences. The building, completed in 1960 and dedicated in May, 1961, doubles the space available for the company's scientific activities.*

degenerative diseases and aging, more must be learned about basic body components and processes and how they are affected by drugs.

Of course, a major portion of the Abbott program is directed toward applied research, developing new products that will treat diseases heretofore unmanageable or will do the job better than products currently available. This may involve the investigation of soils to discover antibiotic-producing organisms. Or it may mean the scrambling of molecules to produce new chemical substances. Or it may require the extraction of biochemical materials from animal tissue. Always is means a large, well-trained scientific staff, large expenditures and long odds that the substance discovered in the laboratory will eventually prove to be an effective and safe drug for use in the living person or animal.

The company's scientific efforts began in 1888 when Dr. Wallace C. Abbott, a Chicago physician, made



▶ TYPICAL CHEMICAL *production center at Abbott Laboratories. Unit with open lid is 1,000 gallon, all purpose, acid-proof reactor that extends beneath the floor. All piping in the labyrinth of plumbing is acid-proof. Center has a distillation column and another for "scrubbing" noxious gases. Planned, controlled chemical reactions in such units change structures of molecules in desired ways.*

his first "dosimetric granules" and became a pioneer of modern pharmaceutical practice.

When Dr. Abbott began his medical practice, most of the medicines available were fluid extracts and tinctures that often were ill-tasting, unstandardized and undependable. In medical school, Dr. Abbott had learned of the teachings of Dr. Adolfe Burggraeve, a Belgian pharmacist, who advocated the use of only the effective portion or "active principle" of drug plants instead of the water or alcohol extracts. This active portion could be administered in definite doses in the form of pure granules.

Dr. Abbott was among the first American physicians to appreciate Dr. Burggraeve's methods, and he located

a small company that was producing the dosimetric granules. But he soon became dissatisfied with this source of supply; he often was unable to get the granules when he needed them, and he suspected the supplier was not treating him squarely.

So. Dr. Abbott began experimenting with and making his own dosimetric granules in his home. His patients were well pleased with them, and other Chicago doctors learned of the granules and began buying them from Dr. Abbott. In 1891, he placed a 25 cent advertisement in the Medical World that brought in $8 worth of orders — orders that put "dosimetric granules" on the medical map and Dr. Abbott definitely in business.

Biologicals

When biological preparations came into the foreground, Dr. Abbott's company began to produce them. In 1909, the company made its first organic synthetic chemicals, the phenolsulfamates (antiseptics and disinfectants), and the nucleus of a research staff was formed.

By 1914, the company had advanced chemically so far beyond its early days that the name was changed from the "Abbott Alkaloidal Company" to Abbott Laboratories as it is known today.

The second phase of the company's scientific efforts, from 1916 to 1927, saw the birth and development of a much wider line of products and an advancement of the company's research activities. In 1916, after the announcement of H. H. Dakin and Elexis Carrel of the germicidal action of the chloramines, Abbott developed Chlorazene, Dichloramine-T and Halazone. The latter, an outgrowth of

► PROTEIN *research, purity checks, studies of nutritional supplements and structural analysis are speeded at Abbott Laboratories by this amino acid analyzer. It separates, records and collects* individual amino acid building *blocks of protein molecules.*

research on Chlorazene, was used extensively in World War I and World War II as a water purification tablet. It is still in the Abbott catalogue and is employed widely in disaster situations where contaminated drinking water is suspected and by Boy Scouts and other campers to insure that the water they drink is safe.

During World War I, the company was asked by the United States government to manufacture certain synthetic substances previously imported from Germany. Abbott scientists developed methods of producing a number of sedatives, hypnotics, analgesics and anesthetics. This work put the company into full-scale synthetic manufacturing.

In 1920, the company introduced Butyn,® a substance for cocaine as a local anesthetic. Experience during the

war in making barbital led, in 1923, to Neonal, an intermediate-length barbiturate. In 1922, Abbott acquired the Dermatological Research Laboratories of Philadelphia where arsphenamine (Ehrlich's famous "magic bullet") was first synthetized in the United States and where, subsequently, neoarsphenamine (a superior agent for treating syphilis) was developed. The D.R.L. group also developed Metaphen,® a powerful but non-stinging antiseptic for wounds, skin sterilization before operations, and for disinfecting dental and surgical instruments.

Third Phase

The third phase of Abbott scientific achievements began in 1925 when the company was moved from Chicago to its present site in the far northern suburb of North Chicago. In the years to 1937 an increasing number of new products came out of the company's growing research laboratories.

Intensive efforts were concentrated on the barbiturates in the attempt to find a short-acting form. This research resulted in 1930 in the introduction of Nembutal,® a short-acting sedative and hypnotic that has become a classic for inducing sleep and preanesthetic sedation. Further research on the barbiturate molecule to shorten its action resulted in the long-sought intravenous anesthetic, which Abbott introduced in 1934 as Pentothal®Sodium, an ultra-short acting anesthetic which also has received wide notice as a so-called "truth serum."

During this period, Abbott pioneered in the production of vitamin supplements that helped to awake the world to the importance of vitamins. With the discovery that halibut liver was richer in Vitamins A and D than cod liver, Abbott and another company erected a vitamin oil extraction plant in Seattle. Several vitamin products were introduced and the company continued intensive research in nutrition, including work on the B-complex and on synthetic vitamins that today largely have replaced fish oils and other natural sources of the ingredients in today's vitamin tablets.

The next Abbott scientific phase began in 1937 when research activities were materially extended and expanded and the tempo stepped up markedly. Hormones, new arsenicals, and sulfa drugs were introduced. Liver extracts multiplied, and heparin, for preventing blood coagulation, was marketed. The company pioneered in the development of vitamin K, a special purpose vitamin that speeds the coagulation of blood in hemorrhage.

World War II

During World War II, the company, along with others in the pharmaceutical industry, devoted much of its attention to penicillin that saved thousands of lives during the war and afterwards. Abbott also performed research on antimalarial drugs in cooperation with Harvard University, the Office of Scientific Research and Development and others. Diasone,® a drug that first showed promise in treating tuberculosis but later failed, proved to be valuable as an oral treatment for leprosy and is widely used in those areas of the world where this disease is a problem.

In 1945 Tridione® was introduced, the first effective treatment for *petit mal* and related forms of epilepsy.

This was the first of several anticonvulsant drugs the company was to market in the next 12 years for the treatment of several types of epilepsy.

Toward the end of World War II, Abbott began work in radio-pharmaceuticals (purified and standardized forms of radio-isotopes) because medical researchers wanted radioactive Pentothal and Nembutal for studies of the way these drugs work in the body. These and other isotope-labeled drugs were made, and, in 1946, a special research department was established to develop the use of radioactive materials in biology and medicine. As a result of these efforts, Abbott in 1948 became the first pharmaceutical company to supply finished radio-pharmaceuticals to medical and research institutions.

At first, processing of the isotopes was carried on at the main plant in North Chicago, but in 1952 the company established a radio-pharmaceutical production center at Oak Ridge, Tennessee, where all of the company's commercial isotope development and production facilities are now consolidated. Until 1960, Abbott obtained all of its crude isotopes from the Atomic Energy Commission's nuclear reactor at Oak Ridge. However, the company now produces some of its own raw material for radio-pharmaceuticals.

Medical Products

During the 1950's a number of medically-important products were developed, including Desoxyn,® central nervous system stimulant and appetite inhibitor; Selsun,® for the control of dandruff and other dermatological conditions; Erythrocin,® an antibiotic especially effective against coccic infections; Tronothane,® a topical anesthetic of low toxicity; Compocillin®-VK, a new and more effective salt of penicillin; Spontin,® a new antibiotic that kills many bacteria outright and is effective in many severe infections, and Tral,® for the treatment of ulcers.

A chance discovery by a graduate chemistry student at the University of Illinois led to the introduction in 1950 of one of the company's most widely-known products. The student had been preparing a number of compounds in his laboratory and paused to light a cigarette. He laid the cigarette on his lab table and when he put it back in his mouth, he noticed it tasted sweet. The student went to work for another chemical company, but the Abbott research director heard one story and began to investigate its possibility as a non-caloric sweetening agent. After nearly a decade of research and development that proved the compound was safe and could be used in a wide variety of food and beverages, it was introduced in 1950 under the trademark of Sucaryl.® Since then it has been used by millions of persons on diabetic or reducing diets.

Major Expansion

A major expansion of scientific efforts was decided upon by management in 1956, and the company began adding gradually and steadily to the scientific staff in anticipation of the new research facilities that were completed in 1960. About half of the more than 800 members of the scientific divisions are professional scientists who hold degrees in a score or more different scientific disciplines. About a third of them are Ph.D.'s and M.D.'s.

During a recent year, more than 18,500 materials from chemical, microbial and other sources were prepared and evaluated at Abbott. In 1961, a record number of potential new drugs were under investigation.

Current basic research projects at Abbott include studies on the functioning of the individual cell, the action of drugs at the cellular and molecular level, nerve growth factors, the mechanism of action of diuretics, and fundamental investigations of cancer, metabolism and host defense mechanisms. One of the company's basic research projects is the study of enzymes that do much of the work of the cell in accelerating the building up and tearing down of chemicals in the body. One phase of enzyme research involves the isolation of enzymes from biochemical material for clinical use in treating disease. Our scientists are investigating an enzyme that appears, in early trials, to be of value in managing certain circulatory diseases.

Enzyme Inhibitors

Another approach is represented by investigations to discover and develop chemicals that affect the action of enzymes. Of particular interest are compounds that inhibit the monamine oxidases, enzymes that have been implicated in metal depression and high blood pressure.

A unique, multi-stage screening program involving biochemical, neuropharmacological, animal and behavioral tests has enabled Abbott to put on clinical trial new types of monamine oxidase inhibitors unlike any currently available.

New Anesthetic

Some drugs have been marketed in a prolonged release dosage form known as the Gradumet,® and others are planned for future introduction. Enduron™, a potent oral diruetic, is proving valuable in lowering blood blood pressure in hypertensive patients and in treating edema, in which excess fluids accumulate in the tissues of the body. Expected to be introduced within the next few months is Penthrane™, a new inhalation enesthetic that is non-flammable and minimizes the possibilities of overdosage. Thousands of compounds are being evaluated in a cancer-screening program. New veterinary products and new chemicals for agriculture and industry also are in various stages of development.

The company's bread line of about 550 products that improve and protect the public health includes many that were not even imagined by the physicians of Dr. Abbott's day. But there are yet major diseases to be conquered. Perhaps someday the basic research that is now being done will result in the control of mental illness, cardiovascular diseases, cancer, metabolic diseases and other organic disorders. It is toward these goals that Abbott and other scientists are striving.

√ Answers to CHEMISTRY QUIZ on Page 32. √
A - 4; B - 3; C - 2; D - 4; E - 1.

Science Talent Search
Project Report

Enzyme-Substrate Complex

Thomas J. McGivern, 17, was a winner in the 20th Science Talent Search. He hopes to major in chemistry at college with a view to becoming a research biochemist.

by THOMAS J. MCGIVERN

Highland Park High School, Highland Park, Illinois

➤ A BIOCHEMISTRY laboratory experiment and an article in *Scientific American* magazine entitled "The Enzyme-Substrate Complex" turned my interest toward enzymes, more specifically, enzyme kinetics and the enzyme-substrate complex. The enzyme-substrate complex is the most logical, and most widely supported and accepted theory for the mechanism of enzyme catalytic action. It is theorized to be a transitory compound of enzyme and substrate, an intermediate action which supposedly distorts the substrate into a highly-reactive state. Leonor Michaelis and Maude Menton, of Berlin, are credited with the proposal of the theory in 1913. Although evidence points to the existence of the complex, the compound itself has never been successfully isolated for study because of its transitory nature.

This study of the enzyme-substrate complex is divided into two parts.

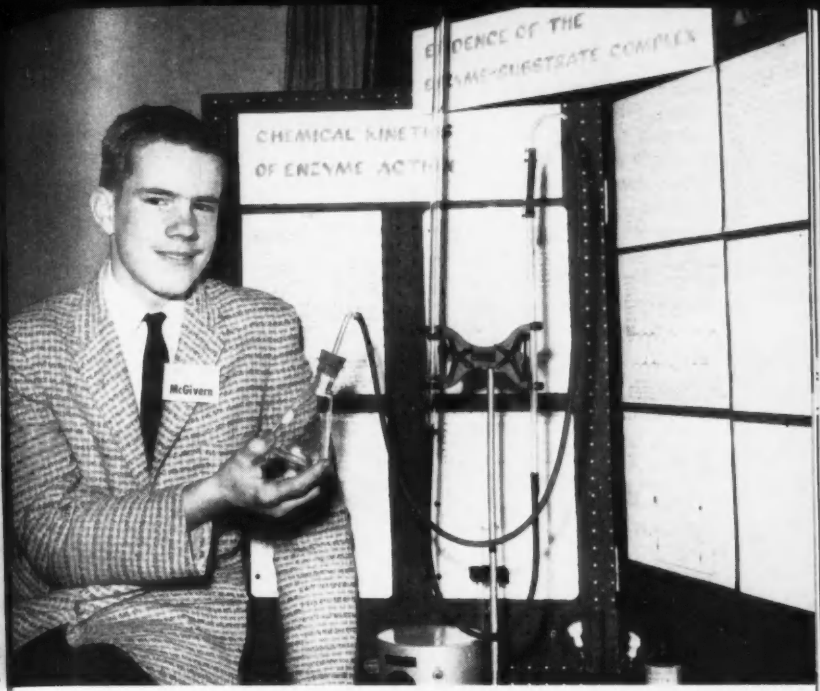
The first is a study of the kinetics, or rates, of the actions of the yeast zymase group and catalase. I am interested here not in the relationship of initial rates to certain variables, but in the progress of each reaction with time. A comparison will be made with the results of Dr. Britton Chance, of th University of Pennsylvania, who measured directly the varying concentration of a complex during reaction; he used specialized mixing and flow techniques and a highly-sensitive spectrophotometer. If, as he concluded, rate of product formation is directly proportional to complex concentration, the curve path on my rate-time graphs map appear roughly similar to that on his complex concentration graph. The second part is a study of heat stabilization of invertase. If a complex is formed, the presence of sucrose substrate during heating may protect the active sites of the invertase molecules from denaturation.

Methods and Materials

Enzymes Used: Catalase and invertase were technical grade, supplied by Nutritional Biochemicals Corporation. Fleischman brand yeast was used.

Incubation: A home-made water bath incubator was used. Yeast was incubated at 30° C and invertase at 38° C. Catalase was not incubated, but run on a magnetic stirrer.

Measurement of Yeast Zymase Activity: Smith tubes were used for this



▶ THOMAS J. MCGIVERN *shows his science display at an exhibition held in Washington as a feature of the twentieth annual Science Talent Institute. Thomas was one of the 40 S.T.S. winners who were chosen from over 29,000 high school seniors throughout the country.*

reaction. Toward the end of the reaction steps, pyruvic acid breaks down to carbon dioxide and acetaldehyde. The carbon dioxide collected and measured in the calibrated sidearm of the tube provided a measure of the net activity of the zymase group. The initial substrate was glucose. Readings were taken every five minutes for one hour.

Measurement of Catalase Activity: A constant-pressure water manometer was constructed to measure the molecular oxygen evolved by the breakdown of hydrogen peroxide substrate. A phosphate buffer of pH 7.0 was used. The reaction was run in a flask on a magnetic stirrer, with readings taken each minute until manometer capacity was reached.

Invertase Experiments: For these experiments, heating was done by immersing test tubes in a boiling water bath. An acetate buffer of pH 4.5 was used with the invertase, and sucrose was the substrate. In one tube, invertase was heated; in a second, invertase with sucrose; and in a third,

invertase with thiamine hydrochloride, a substance chosen at random. Three more tubes served as controls: one contained invertase and sucrose, another contained only invertase, and a third had glucose solution. The latter three were not heated. After heating and cooling, sucrose was added to the first and third tubes, and then all were incubated for 16-24 hours. Each was then analyzed with Benedict's Qualitative Sugar Reagent. Enzyme activity was determined by detecting glucose, one of the reaction products.

Results

The readings taken during kinetics experiments were plotted on graphs, with amount of product formed as ordinates and time as abscissas. Some were also plotted with rate of product formation as ordinates and time as abscissas. The curve shapes for catalase and for the yeast zymase group appeared quite similar. First, there was a short initial increase in rate. The rate then leveled off to a steady state. Finally it began to decline slowly and would have reached zero if followed further.

Results of the heat stabilization experiments as indicated by Benedict's Qualitative Reagent were as follows: tubes with invertase alone (heated) showed no glucose. The tubes heated with invertase and sucrose showed a significant amount of glucose. The tubes heated with enzyme and thiamine gave an inconclusive result, but there was probably no glucose. The unheated tubes containing invertase and sucrose showed more glucose than the heated ones of the same type. The control tubes indicated that the analysis was probably valid.

Discussion

The actual rates of action of different enzymes will differ because some are more active than others; this activity is indicated by the turnover, the maximum number of substrate molecules whose conversion is catalyzed by one enzyme molecule in one minute at a standard temperature. The *shape* or *path* of rate curves of different enzymes may be quite similar, however. The transient phase (initial rate increase) is probably due to an initial buildup of complex concentration. The steady state, present when the substrate supply is in excess relative to that of the enzyme, is a zero-order reaction; the rate here is limited by the complex-forming capacity of the particular enzyme. The decline is due to a decrease in complex concentration; it follows the course of a first-order reaction, which ideally is proportional to decreasing reactant concentration. However, in enzymes, this decline is often caused by inhibition of the enzyme by its own substrate, a product, or extraneous materials. The comparison with Dr. Chance's graph showed the two to be somewhat similar. Although my experiments are not accurate enough to be conclusive, it does appear that, during any time in the reaction, rate of product formation is directly proportional to concentration of the intermediate complex at that time.

In the invertase heat stabilization experiments, the activity of invertase when heated alone was destroyed as expected. However, when heated with sucrose substrate, it retained some of its activity. This partial protection may be due to a complex formation. The effect of thiamine hydrochloride

has not been elucidated clearly, but it probably offers no protection to the enzyme, that is, does not complex with it. In the future, I would like to test the heat stabilization effect of certain dyes which are known to complex with invertase. Also, I may try equilibrium dialysis with invertase and dye to see how many dye molecules are complexed per invertase molecule.

Some error has undoubtedly been instilled into these experiments through the use of technical grade enzymes and through my lack of knowledge of many techniques. The yeast zymase group, besides being composed of twelve enzymes, catalyzes reactions which are a metabolic process, and thus there are also some side reactions. However, these experiments have answered some of my questions and have taught me a great deal. This paper covers the work of about five months, two for preliminary preparations and three for actual experimentation. The work was done from December 1959 to May 1960, during the school year.

The Enzyme-Substrate Complex

Enzymology is an important area of biochemistry, for without the action of these biological catalysts, life would be virtually impossible. However, it is not enough to say that enzymes act as catalysts. We want to know the mechanism for enzyme catalysts. The enzyme-substrate complex is the most logical mechanism, most widely accepted, and strongly reinforced by experimental evidence. The complex is a transitory, intermediate compound of the enzyme and its substrate. All attempts to isolate the complex and study it have failed, due to its extremely short life.

My work consisted of two studies. First, I decided the reaction rates of two systems: the anerobic metabolism of glucose, catalyzed by the twelve enzymes of the yeast zymase group, and the breakdown of hydrogen peroxide, catalyzed by catalase. Results of reaction rate studies often give clues as to the reaction mechanism involved. The second part was a study of the heat stabilization of invertase by its substrate sucrose. Ordinarily the active sites, centers of catalytic activity on the enzyme molecules, are denatured and lose their activity when subjected to heat. However, I found that when sucrose was present during heating of invertase, the enzyme was protected and retained some activity. This effect may well be due to the formation of the enzyme-substrate complex.

Data from Experiment 2

Tube 1:	invertase, water, buffer	(sucrose added after heating)
Tube 2:	invertase, water, buffer, sucrose	(water added after heating
Tube 3:	invertase, water, buffer, thiamine hydrochloride	(sucrose added after heating)
Tube 4:	invertase, water, buffer, sucrose	(control, not heated)

Tubes 1, 2, 3, heated at 80° C for 2 min., then all tubes incubated at 38° C for 22 hours.

Analysis

	Color of Sample	*Interpretation*	*Reason*
Tube 1:	Blue	No glucose	Enzyme inactivated
Tube 2:	Blue-green	Glucose produced	Enzyme protected
Tube 3:	Blue, slight white pp't	No Significant action	Uncertain-enzyme probably unprotected
Tube 4:	Yellow-green	More glucose than #2	Control, not heated Optimum conditions

Reagents Used

Yeast Zymase	*Concentration*	*Amount in each reaction unit*
d-Glucose	10%	2ml
sodium iodoacetate	0.02M	(2ml, inhibitor)
potassium biphosphate	0.045M	2ml
media		
thiamine hydrochloride	0.34g/liter	5ml
magnesium sulfate	0.65g/liter	
manganous sulfate	0.21g/liter	
yeast suspension	4g/25ml water	5ml
Catalase		
hydrogen peroxide	3%	2ml
tech. catalase solution	0.5ml/100ml water	2ml
buffer- pH 7.0		
sodium hydroxide	0.1M	4ml
potassium biphosphate	0.1M	
Invertase		
sucrose	5%	1ml
tech. invertase solution	0.2 ml/100ml water	5ml
buffer- pH 4.5		
acetic acid	0.1M	2ml
sodium acetate	0.1M	

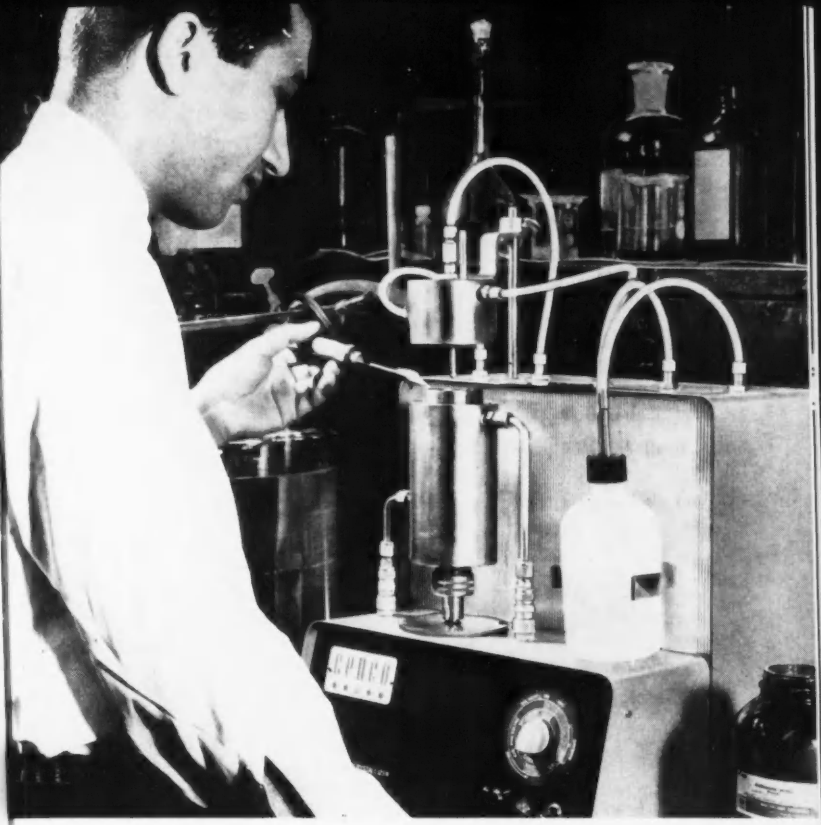
The above amounts may be varied for different experiments

Benedict's Qualitative Sugar Reagent

8 drops test in 5ml Benedict's, or

4 drops test in 2.5ml Benedict's

Heat samples 5 min. in boiling water, a precipitate indicates presence of glucose.



Apparatus Article

Automatic Recrystallizer

A NEW recrystallizer which automatically purifies small quantities (about one gram) of organic compounds in the laboratory with a minimum of attention by laboratory personnel has been introduced by Central Scientific Company, a division of Cenco Instruments Corporation.

Called the Automatic Recrystallizer, the new instrument is designed to be particularly useful where very pure materials are required for analysis, comparison or inspection in analytical or industrial quality control laboratories. It also allows the use of the more economical, lower grade chemi-

cals which usually deterioriate in shipment or storage. These chemicals can be upgraded immediately in the laboratory using the Automatic Recrystallizer.

The Automatic Recrystallizer is of particular value in the laboratory because it is fully automatic and releases personnel for more valuable nonroutine work. It gives precise control over purification parameters and is excellent for qualitive analysis work.

The Recrystallizer's one-hour program may be continuously repeated and stopped automatically after one cycle.

The new instrument requires only a space of 12 inches by 12 inches on the laboratory bench and can be used in any laboratory equipped with normal utilities. The unit requires connections only to an air pressure outlet about 25 inches Hg, and cold or hot water (or oil or steam).

The crystallizer chamber is made of stainless steel and monel metal throughout, the connecting tubing of polyethylene, all of which are corrosion resistant and easily cleaned. The unit weight about 25 pounds.

Complete technical data on the Automatic Recrystallizer may be obtained by writing Central Scientific Company, a division of Cenco Instruments Corporation, 1700 West Irving Park Road, Chicago 13, Illinois, U.S.A.

Arthritis Research Clue

➤ Promising results in treating rheumatic disorders of a small group of patients with epsilon amino caproic acid, or EACA, were reported.

Dr. Jerome Rotstein of Montefiore Hospital found this important research clue for the study of connective tissue diseases, of which rheumatoid arthritis is the most severe.

EACA was first synthesized by German chemists in 1907, and in 1953 Japanese scientists reported that it had potential use in control of acute bleeding conditions associated with high plasmin levels. It was this factor that led Dr. Rotstein and his colleagues to undertake exploratory studies for its possible use in treating connective tissue diseases.

No conclusive results have been shown yet in the treatment of rheumatoid arthritis, but progressive systematic sclerosis, a severe connective tissue disease, has responded to the compound.

EACA acts on an enzyme system, which is the fibrinolytic system believed to be involved in the mechanism of inflammation. It blocks the activation of plasminogen into plasmin, which reduces fibrin, an insoluble gel form of fibrogen that occurs during the clotting of blood.

When fibrin is split up (fibrinolysis), the remaining fibrin products are believed to be involved in the development of fibrinoid lesions present in arthritis and in other inflammatory lesions.

Lederle Laboratories at Pearl River, N. Y., has been doing development work on EACA, but there is no prospect of its commercial production at this time.

New Chemical Patents

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupon (but not stamps) for each patent ordered.

Fracturing Oil Wells Using Calcium Carbide

➤ IN THE USUAL method of fracturing a well, the zone of the well to be fractured is packed off and a fracturing fluid is injected into the isolated zone. The pressure of the fracturing fluid is increased, usually by the injection of additional quantities of the fluid, until the isolated zone is ruptured or fractured.

When using this method, the energy available for fracturing is derived solely from mechanical apparatus located at the surface of the well. As a result, the force which may be developed in the desired zone has a very definite limitation, thereby limiting the extent to which the well may be fractured.

Michael W. Barrett of Seminola, Oklahoma, has devloped an improved method for fracturing oil wells which utilizes calcium carbide. He has been awarded U. S. Patent No. 2,943,681 for his invention. The patent is unassigned.

His method involves the pumping of calcium carbide suspended in a liquid hydrocarbon carrier into the zone of the well to be fractured. This is followed by sufficient water to react with the calcium carbide to form acetylene. The force developed from this reaction is sufficient to rupture or fracture the zone.

This method increases the size of the fractures around a well without increasing the horsepower requirements of the apparatus used. It also utilizes chemical energy in the place of mechanical energy.

Protection Against Frost Damage

➤ FROST OR freezing temperatures cause heavy economic losses in many forms of plant life. A simple and inexpensive method of preventing or minimizing frost to plant life has long been sought. Previous methods include preventing heat radiation by the use of smoke, heating of the air by fuel burners and providing cover for plants in the form of paper or cloth shields.

Louis E. Wells of Jackson, Mississippi has developed a new method for protecting living plants from frost damage. He was given U. S. Patent No. 2,961,798 for his invention. The patent was assigned to Dumas Milner Corporation of Mississippi.

His method consists in applying to the plants butyrolactone, 2-pyrrolidone or N-lower alkyl-2-pyrrolidone. This is accomplished with a spray containing from 0.01 percent to about 2 percent of the compound. The spray also contains water, oil-in-water emulsions, glycols, oils or other non-phytotoxic liquid carriers.

Book Condensations

CHEMISTRY FOR THE SPACE AGE — Dan Q. Posin — *Lippincott,* 680 p., illus., $5.60. Lively introduction to chemistry with tests, application exercises and problems to solve following each of the 62 sections.

CHEMISTRY FOR CHILDREN — Virginia L. Mullin — *Sterling,* 117 p., illus. by Bernard Case, $2.95. Introduces boys and girls to the language of chemistry and laboratory techniques, and gives instruction for many experiments.

NATURAL POLYMER MAN-MADE FIBERS — C. E. Carroll-Porczynski — *Academic Press,* 303 p., illus., $11.20. Presents results of recent scientific investigations for readers engaged in manufacture or in research and development work of organic man-made fibers.

PLASTICS IN NUCLEAR ENGINEERING — James O. Turner — *Reinhold.* 139 p., illus., $5.50. Covers practical plastics applications from the viewpoint of the engineering dealing with nuclear research apparatus.

THE ORGANIC CHEMISTRY OF BORON — W. Gerrard — *Academic Press,* 308 p., $9. Monograph treats comprehensively the reactions and techniques used in the organic chemistry of boron.

ANALYTICAL CHEMISTRY OF THE RARE EARTHS — R. C. Vickery — *Pergamon,* 137 p., illus., $6.50. Considers gravimetric, volumetric, spectrophotometric, spectrographic, X-ray and polarographic techniques of analysis.

A SYSTEMATIC LABORATORY COURSE IN GENERAL CHEMISTRY — Harry H. Sisler, Jay H. Stewart and W. T. Lippincott — *Macmillan,* 2nd ed., 358 p., illus., paper, $4. Revision emphasizes quantitative experiments and importance of the student's own interpretation of experimental results obtained.

EXPERIMENTAL NUCLEAR CHEMISTRY — Gregory R. Choppin — *Prentice-Hall,* 226 p., illus., $9.25. Combines basic theory with the latest techniques in the expert use of radioisotopes in modern research, describes experiments using license-free quantities of radioisotopes of low activity, thus eliminating special safety requirements.

PHYSICAL CHEMISTRY OF MACROMOLECULES — Charles Tanford — *Wiley,* 710 p., illus., $18. Graduate text and reference book, emphasis on theoretical principles, major areas treated are molecular structure, thermodynamics, light scattering, viscosity, electrostatics, and equilibria and kinetics of reactions.

CHEMISTRY — Michell J. Sienko and Robert A. Plane — *McGraw,* 2nd ed., 623 p., illus., $7.50. First-year college courses emphasizing principles, with hunderds of problems that call for comprehension in their solution.

SEPARATION PROCESSES IN PRACTICE — Robert E. Chapman, Ed. — 209 p., illus., $4.95. Practical information for the young chemical engineer.

Chemistry Comments

➤ Matches can be water-proofed by dipping tips in melted paraffin.

➤ The chief advantages of radioisotope-fueled generators for space use are their small size, light weight, long life and reliability.

➤ Under heavy fallout conditions, a shield of one to two yards of earth or concrete is needed for full protection against gamma radiation.

➤ A 10% to 20% loss of salt from the body leads to loss of will to work.

➤ Isinglass, mineral mica, formerly used as windows in oil stoves, now is of strategic importance to the electronics industry because of its excellent electrical insulating properties.

➤ Corrosion of iron and steel in salt water is an electrochemical phenomenon.

➤ Over half of all the money that the U.S. has spent on research and development in its entire history has been spent in the last 10 years.

➤ The mechanical properties of acrylic plastics are improved by the alignment of molecules in the plane of the sheet.

➤ Azaleas and camellias cannot tolerate high soil salinity although they grow best in acid soils.

➤ A remote-controlled miniature chemistry laboratory which will break down small samples of the moon's soil and report back to earth what chemicals it finds is being developed to be landed on the moon in 1963.

➤ Cadmium has long been recognized as a potentially toxic material to humans.

➤ Ancient man mined large quantities of gypsum minerals from caves in Mammoth Cave National Park area 3,000 years ago.

➤ Plasma, termed the "fourth state of matter," along with solid, liquid and gas, is simply very hot, electrically charged gas, observed in such everyday uses as fluorescent lamps and electric arc lamps.

➤ Boron, used in high energy rocket fuels, is now applied to cancer research.

➤ Radioactive krypton used for measuring cerebral blood flow is largely eliminated during a single trip through the circulation.

➤ Laboratory-grown "whiskers" consisting of a single crystal of alumia can withstand tensions up to several million pounds per square inch.

➤ The strength of pure silver is increased five times by blending into it a small percentage of tiny sapphire "whiskers."

➤ Sheep fed alfalfa pellets containing 5% of dicalcium phosphate are protected against poisonous oxalates in weed.

➤ The traditional method of making leather may be revolutionized by a new proteolytic enzyme, keratinase, which removes natural hair from hides without affecting them, producing a better quality leather.